



Науковий вісник Львівського національного університету
ветеринарної медицини та біотехнологій імені С.З. Гжицького.

Серія: Ветеринарні науки

Scientific Messenger of Lviv National University
of Veterinary Medicine and Biotechnologies.

Series: Veterinary sciences

ISSN 2518–7554 print

ISSN 2518–1327 online

doi: 10.32718/nvlvet10705

<https://nvlvet.com.ua/index.php/journal>

UDC 636.09:639.1.09:616.99

The influence of the drugs “Brovermectin-granulate™” and “Avesstim™” on indicators of non-specific resistance of one year-old carp fish infested with monogeneans

O. V. Fedorovych¹✉, V. V. Stybel¹, B. V. Gutyj¹, I. S. Starostenko², S. V. Tkachenko², I. V. Tytarenko², N. I. Klopenko², Ju. Kunovskii², P. I. Kuzmenko²

¹Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv, Ukraine

²Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine

Article info

Received 13.06.2022

Received in revised form

13.07.2022

Accepted 14.07.2022

Stepan Gzhytskyi National
University of Veterinary Medicine
and Biotechnologies Lviv,
Pekarska Str., 50, Lviv,
79010, Ukraine.

Tel.: +38-063-983-08-02

E-mail: qnc_sn@ukr.net

Bila Tserkva National Agrarian
University, Pl. Soborna 8/1,
Bila Tserkva, Kyiv region,
09117, Ukraine.

Fedorovych, O. V., Stybel, V. V., Gutyj, B. V., Starostenko, I. S., Tkachenko, S. V., Tytarenko, I. V., Klopenko, N. I., Kunovskii, Ju. Kuzmenko, P. I. (2022). The influence of the drugs “Brovermectin-granulate™” and “Avesstim™” on indicators of non-specific resistance of one year-old carp fish infested with monogeneans. Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies. Series: Veterinary sciences, 24(107), 29–34. doi: 10.32718/nvlvet10705

The article presents data on the study of the influence of the drugs “Brovermectin-granulate™” and “Avesstim™” on indicators of non-specific resistance of one-year-old carp fish infested with monogeneans. For conducting experiments, 14 experimental groups were formed (two groups of each species of fish affected by *Dactylogyrus lamellatus*, *Gyrodactylus hypophthalmichtidis*, *Eudiplozoon nipponicum*). The fish of the first experimental group were administered “Brovermectin-granulate™”, and the second experimental group were administered a complex of drugs “Brovermectin-granulate™” and “Avesstim™”. Fish infected with various ectoparasites (*Dactylogyrus lamellatus*, *Gyrodactylus hypophthalmichtidis*, *Eudiplozoon nipponicum*) served as controls. Fish of each group were kept in separate aquariums with a capacity of 40 dm³ with artificial aeration at a temperature of 20–22 °C. Their care and feeding was carried out according to the relevant norms and rations. During the entire period of research, the behavior and clinical condition of the fish were observed. The pre-experimental period of acclimatization of annuals was 7 days. The use of the drug “Brovermectin-granulate™” to one-year-old white carp, crucian carp and scaly carp affected by monogeneans had a stimulating effect on the resistance of their organism. At the same time, the simultaneous use of the specified drug with the immunomodulator “Avesstim™” contributed to better activation of the humoral link of non-specific immunity in sick fish. To normalize the organism homeostasis, correct metabolism and activate the humoral link of non-specific immunity during a monogenoid invasion of carp, it is recommended to feed them with a combined feed of the drugs “Brovermectin-granulate™” and the immunomodulator “Avesstim™”.

Key words: carp fish, immunomodulators, immune system, *Dactylogyrus lamellatus*, *Gyrodactylus hypophthalmichtidis*, *Eudiplozoon nipponicum*.

Introduction

Ichthyopathological control of inland water of Ukraine, development of ecologically safe methods of prevention of fish diseases is a component of general ecological monitoring of natural ecosystems and measures aimed at preserving biodiversity and rational use of biological resources (Bozhyk & Pukalo, 2012; Kofonov et al., 2020; Prychepa et al., 2021).

The epizootic state of reservoirs significantly affects to their fish productivity. Studying the patterns of the

occurrence and spread of fish diseases and also their prevention is an important problem of modern fish farming, since the efficiency of breeding aquaculture facilities and the preservation of fish products depends on its solution (Davydov et al., 2013; Dzhamil, 2013).

A number of factors contribute to the spread of fish diseases, the main of which are insufficient veterinary supervision during the transportation of fish, violations of quarantine measures, low technological culture and quality of artificial feed, deterioration of the ecological situation in reservoirs and growing conditions. For the early

diagnosis of pathological changes in the body of fish, immunological, hematological, biochemical and histological studies are indicative (Zurawski et al., 2001; Jevtushenko et al., 2015; Fedorovych & Gutyj, 2019).

It is known from literary sources that parasitic diseases in fish cause disorders of the immune system. Accordingly, this causes increased sensitivity of fish to conditionally pathogenic microflora and other biotic and abiotic factors of the environment. To eliminate the pathogenic effect of ectoparasites on the fish' organism, it is advisable to use immunomodulators in combination with antiparasitic drugs. This will not only increase the effectiveness of therapy, but also increase the immune status and resistance of the fish body. Loboyko Yu. V. and others (Lobojko, 2012; Loboiko et al., 2017) established that the complex use of the drug "Brovermectin-granulate TM" and the immunomodulator "Avesstim TM" for carp lemeosis promotes the activation of the immune system, and the acceleration of the recovery of damaged tissues and cells, the improvement of hemodynamics, metabolism and the general state of the body. In view, we studied the influence of the drugs "Brovermectin-granulate TM" and "Avesstim TM" on the indicators of non-specific resistance of one-year-old white carp and crucian carp, infested with dactylogyrus and hydrodactylus, and scaly carp infested with diplozoans.

The purpose of the work

The purpose of the work is to study the influence of the drugs "Brovermectin-granulate TM" and "Avesstim TM" on the indicators of non-specific resistance of one-year-old carp fishes infested with monogeneans (*Dactylogyrus lamellatus*, *Gyrodactylus hypophthalmichthidis*, *Eudiplozoon nipponicum*).

Research material and methods

For conducting experiments, 14 experimental groups were formed (two groups of each species of fish affected by each of the above parasites). The fish of the first experimental group were administered "Brovermectin-granulate TM", the second experimental group were administered a complex of drugs "Brovermectin-granulate TM" and "Avesstim TM". Fish infected with various ectoparasites served as controls.

Fish of each group were kept in separate aquariums with a capacity of 40 dm³ with artificial aeration at a temperature of 20–22 °C. Their care and feeding was carried out according to the relevant norms and rations.

Table 1

Indicators of non-specific resistance in the blood of one-year-old white carp infested with *Dactylogyrus lamellatus*, before and after the use of drugs, M ± m (n = 6)

| Indicators | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 37.71 ± 0.613 | 38.83 ± 0.550 | 39.92 ± 0.544* |
| Bactericidal activity, % | 25.02 ± 0.602 | 26.60 ± 0.512 | 27.33 ± 0.522* |
| Phagocytic activity, % | 37.13 ± 0.558 | 38.00 ± 0.532 | 39.40 ± 0.648* |
| Phagocytic index, units. | 8.78 ± 0.286 | 9.04 ± 0.247 | 9.51 ± 0.263 |
| Phagocytic number, units. | 3.25 ± 0.068 | 3.43 ± 0.063 | 3.74 ± 0.065*** |

Note: * – P < 0.05, *** – P < 0.001 – compared to the control group

During the entire period of research, the behavior and clinical condition of the fish were observed. The pre-experimental period of acclimatization of annuals was 7 days.

Treatment of infested fish with the drug "Brovermectin-granulate TM" (at the rate of 60 mg/kg of fish weight) and a complex of drugs "Brovermectin-granulate TM" (60 mg/kg of fish weight) and "Avesstim TM" (1 mg/kg of fish weight) was carried out two days in a row by introducing them orally with the help of a probe into the anterior part of the intestine. Before use, the drugs in the specified doses were mixed with 1 ml of 2 % starch paste. Only 1 ml of 2 % paste was administered to the fish of the control groups. On the 14th day after the use of the drugs, a parasitological examination of the fish was performed and blood was taken for research. In the blood of the fish, the same indicators were studied as in the first stage of the experiment.

The natural resistance of experimental fish was studied by a complex of humoral blood factors. Lysozyme activity of blood serum was determined by the nephelometric method described by V. G. Dorofeychuk (1986), bactericidal activity of blood serum by the photocolometric method described by L. V. Novikova et al. (1981), phagocytic activity of blood neutrophils was determined according to V. E. Chumachenko (1990), the phagocytic index is the number of phagocytosed microbial bodies per active neutrophil and characterizes the absorption capacity of phagocytes, the phagocytic number is the number of phagocytosed microbial bodies per 100 counted neutrophils (Vlizo, 2012).

The analysis of research results was carried out using the Statistica 6.0 software package. The probability of differences was assessed by Student's t-test. The results were considered reliable at P ≤ 0.05.

Results and their discussion

It was established that the use of the above-mentioned drugs in the treatment of one-year-old carp fish infested with monogeneans contributed to an increase in non-specific resistance indicators. Thus, in one-year-old white carp infested with *Dactylogyrus lamellatus*, which were treated with the drug "Brovermectin-granulate TM", the lysozyme activity of the blood serum increased by 1.12 % compared to the control group, the bactericidal activity by 1.58, the phagocytic activity of blood neutrophils by 0.87 %, the phagocytic index by 0.26 and the phagocytic number by 0.18 units. (Table 1).

A significantly greater stimulating effect of “Brovermectin-granulate TM” on indicators of non-specific resistance of fish affected by parasites was observed when it was used together with the immunomodulator “Avesstim TM”. This is evidenced by the probable growth of all the investigated indicators (the exception is the phagocytic index). Thus, the lysozyme activity of blood serum in one-year-old white carp treated simultaneously with both of the above-mentioned drugs increased by 2.21 % (P < 0.05), bactericidal activity by 2.31 % (P < 0.05), phago-

cytic activity of blood neutrophils – by 2.27 % (P < 0.05), phagocytic index – by 0.73, and phagocytic number – by 0.49 units. (P < 0.001). According to these indicators difference was also observed between the fish of the first and second research groups and it amounted to 1.09; 0.73; 1.40 %; 0.47 and 0.31 units. (P < 0.01).

Similar changes in indicators of non-specific resistance were noted in the blood of one-year-old white carp affected by hydrodactylus (Table 2).

Table 2

Indicators of non-specific resistance in the blood of one-year-old white carp infested with *Gyrodactylus ctenopharyngodonis*, before and after the use of drugs, M ± m (n = 6)

| Indicators | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 37.35 ± 0.592 | 38.52 ± 0.589 | 39.65 ± 0.594* |
| Bactericidal activity, % | 24.75 ± 0.606 | 26.43 ± 0.568 | 27.45 ± 0.525** |
| Phagocytic activity, % | 36.98 ± 0.593 | 37.80 ± 0.527 | 39.05 ± 0.551* |
| Phagocytic index, units. | 8.86 ± 0.258 | 9.03 ± 0.216 | 9.35 ± 0.208 |
| Phagocytic number, units. | 3.27 ± 0.053 | 3.41 ± 0.046 | 3.65 ± 0.044*** |

Note: * – P < 0.05, ** – P < 0.01, *** – P < 0.001 – compared to the control group

After treatment with the drug “Brovermectin-granulate TM”, the lysozyme activity of their blood serum increased by 1.17, the bactericidal activity by 1.68, the phagocytic activity of blood neutrophils by 0.82 %, the phagocytic index by 0.17, and the phagocytic number by 0.14 units. The condition of the humoral link of their immune system improved even more when using two drugs at the same time. The above indicators in the fish of the second experimental group compared to the control group increased by 2.30 (P < 0.05), 2.70 (P < 0.01), 2.07 % (P < 0.05), 0, 49 and 0.38 units. (P < 0.001), and in individuals of the second experimental group compared to the first experimental group – by 1.13; 1.02; 1.25 %; 0.32 and 0.24 units. (P < 0.01).

Under conditions of mixed infestation, a positive effect of “Brovermectin-granulate TM” and “Avesstim TM” on the immune system of sick fish was also observed (Table 3). The stimulating effect of these drugs on the natural resistance of the body of fish affected simultaneously by dactylohyrus and hydrodactylus is evidenced by the increase in indicators of the humoral link of immunity in them, namely: lysozyme and bactericidal activity of blood serum, phagocytic activity of blood neutrophils and phagocytic index and phagocytic number in the fish of the first test groups compared to the control group increased by 0.78, respectively; 2.03 (P < 0.05); 1.12 %; 0.07 and 0.13 units. (P < 0.05), and in individuals of the second research group by 2.17 (P < 0.05); 3.91 (P < 0.001); 2.57 % (P < 0.01); 0.52 and 0.44 units. (P < 0.001).

Table 3

Indicators of non-specific resistance in the blood of one-year-old white carp infested with *Dactylogyrus lamellatus* and *Gyrodactylus ctenopharyngodonis*, before and after the use of drugs, M ± m (n = 6)

| Indicator | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 36.45 ± 0.527 | 37.23 ± 0.463 | 38.62 ± 0.489* |
| Bactericidal activity, % | 24.02 ± 0.507 | 26.05 ± 0.536* | 27.93 ± 0.547*** |
| Phagocytic activity, % | 35.90 ± 0.496 | 37.02 ± 0.493 | 38.47 ± 0.397** |
| Phagocytic index, units. | 9.04 ± 0.215 | 9.11 ± 0.166 | 9.56 ± 0.114 |
| Phagocytic number, units. | 3.24 ± 0.039 | 3.37 ± 0.035* | 3.68 ± 0.032*** |

Note: * – P < 0.05, ** – P < 0.01, *** – P < 0.001 – compared to the control group

According to the investigated indicators of natural resistance there was also a difference between the yearlings of white carp of the first and second research groups, but it was reliable only in terms of bactericidal activity of blood serum, phagocytic activity of blood neutrophils and phagocytic number. According to these indicators, the fish of the second experimental group prevailed over the individuals of the first experimental group by 1.88 (P < 0.05); 1.45 % (P < 0.05) and 0.31 units. (P < 0.001).

During the study of the pathogenic effect of ectoparasites on the fish’ organism, we established that the indicators of non-specific resistance differed significantly in one year-old carp affected by *Dactylogyrus hypophthalmichthidis* and in fish treated with the drugs “Brovermectin-granulate TM” and “Avesstim TM” (Table 4). The indicators of the humoral link of protection improved significantly in fish treated with the drug “Brovermectin-granulate TM” compared to the control group, but a significant increase was noted only in the bactericidal activity

of blood serum and the phagocytic activity of blood neutrophils respectively by 1.02 ($P < 0.01$) and 1.34 % ($P < 0.05$).

Fish that were treated simultaneously with two drugs were characterized by significantly better natural resistance compared to the control and individuals that were treated only with “Brovermectin-granulateTM”. Thus, their serum lysozyme activity increased by 1.82 ($P < 0.05$) and 1.07 %, bactericidal activity by 2.80 ($P < 0.001$) and 1.78 % ($P < 0.001$), phagocytic activity of blood

neutrophils by 4.19 ($P < 0.001$) and 2.85 % ($P < 0.001$), phagocytic index by 1.13 ($P < 0.001$) and 1.21 units. ($P < 0.001$) and phagocytic number by 0.85 ($P < 0.001$) and 0.78 units. ($P < 0.001$).

When treating one-year-old white carp affected by *Gyrodactylus hypophthalmichtidis* with the drug “Brovermectin-granulateTM”, the above-mentioned indicators compared to the control increased by 0.90, respectively; 1.02 ($P < 0.05$), 0.98 %; 0.25 and 1.18 units. (Table 5).

Table 4

Indicators of non-specific resistance in the blood of one-year-old carp infested with *Dactylogyrus lamellatus*, before and after the use of drugs, $M \pm m$ ($n = 6$)

| Indicator | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 38.93 ± 0.547 | 39.68 ± 0.514 | 40.75 ± 0.494* |
| Bactericidal activity, % | 26.03 ± 0.222 | 27.05 ± 0.197** | 28.83 ± 0.322*** |
| Phagocytic activity, % | 36.08 ± 0.399 | 37.42 ± 0.324* | 40.27 ± 0.328*** |
| Phagocytic index, units. | 9.35 ± 0.143 | 9.27 ± 0.212 | 10.48 ± 0.040*** |
| Phagocytic number, units. | 3.37 ± 0.055 | 3.44 ± 0.060 | 4.22 ± 0.045*** |

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ – compared to the control group

Table 5

Indicators of non-specific resistance in the blood of one-year-old carp infested with *Gyrodactylus hypophthalmichtidis*, before and after the use of drugs, $M \pm m$ ($n = 6$)

| Indicators | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 38.82 ± 0.589 | 39.72 ± 0.567 | 40.78 ± 0.513* |
| Bactericidal activity, % | 26.08 ± 0.257 | 27.10 ± 0.279* | 28.55 ± 0.347*** |
| Phagocytic activity, % | 36.10 ± 0.356 | 37.08 ± 0.419 | 39.97 ± 0.427*** |
| Phagocytic index, units. | 9.53 ± 0.261 | 9.78 ± 0.248 | 9.82 ± 0.295 |
| Phagocytic number, units. | 3.44 ± 0.079 | 3.62 ± 0.072 | 3.92 ± 0.100** |

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ – compared to the control group

With the simultaneous use of the above-mentioned drug with the immunomodulator “AvesstimTM”, the investigated indicators of the humoral link of non-specific resistance in one-year-old carp compared to the control probably increased (the exception is the phagocytic index): lysozyme activity of blood serum by 0.96 ($P < 0.05$), bactericidal activity by 2.47 ($P < 0.001$), phagocytic activity of blood neutrophils by 3.87 % ($P < 0.001$), phagocytic index by 0.29 and phagocytic number by 0.48 units. ($P < 0.01$).

According to most of the investigated indicators, a significant difference was also observed between the fish of the first and second experimental groups, namely: the

bactericidal activity of blood serum in individuals that were treated simultaneously with two drugs compared to fish that were injected only with “Brovermectin-granulateTM” increased by 1, 45 ($P < 0.01$), the phagocytic activity of blood neutrophils by 2.89 % ($P < 0.001$) and the phagocytic number by 0.30 units. ($P < 0.05$).

There was a positive effect of the studied drugs on indicators of the humoral defense of the body of one-year-old carp and their simultaneous damage by *Dactylogyrus hypophthalmichtidis* and *Gyrodactylus hypophthalmichtidis*, although it should be noted that it was smaller than on the fish’ organism affected by only one parasite (Table 6).

Table 6

Indicators of non-specific resistance in the blood of one-year-old carp infested with *Dactylogyrus lamellatus* and *Gyrodactylus hypophthalmichtidis*, before and after the use of drugs, $M \pm m$ ($n = 6$)

| Indicators | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 37.12 ± 0.534 | 38.28 ± 0.509 | 40.02 ± 0.490** |
| Bactericidal activity, % | 24.83 ± 0.302 | 26.30 ± 0.374* | 28.03 ± 0.454*** |
| Phagocytic activity, % | 35.02 ± 0.289 | 36.63 ± 0.220** | 39.57 ± 0.282*** |
| Phagocytic index, units. | 9.40 ± 0.219 | 9.43 ± 0.218 | 9.23 ± 0.238 |
| Phagocytic number, units. | 3.29 ± 0.071 | 3.45 ± 0.071 | 3.65 ± 0.090* |

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ – compared to the control group

It was established that in the fish treated with “Brovermectin-granulate™”, all the above-mentioned indicators increased, however, this increase was probable only according to the bactericidal activity of blood serum by 1.47 (P < 0.05) and the phagocytic activity of blood neutrophils by 1.61 % (P < 0.01).

Simultaneous use of “Brovermectin-granulate™” and “Avesstim™” had a much better effect on indicators of non-specific resistance of infested fish. In fish treated simultaneously with two drugs, the lysozyme activity of the blood serum, compared to the control and individuals of the first experimental group, increased by 2.90 (P < 0.01) and 1.74 (P < 0.05), respectively, bactericidal activity by 3.20

(P < 0.001) and 1.73 (P < 0.05), phagocytic activity of blood neutrophils by 4.55 (P < 0.001) and 2.94 % (P < 0.001), phagocytic index by 0.17 and 0.20 and the phagocytic number by 0.36 (P < 0.01) and 0.20 units.

A diplozoic invasion also has a significant negative impact on the immune status of fish. The results of our research show that the indicators of non-specific resistance in one-year-old scaly carp affected by *Eudiplozoon nipponicum* significantly worsened. However, the use of the antiparasitic drug “Brovermectin-granulate™” and the immunomodulator “Avesstim™” to the infested fish had a positive effect on the humoral link of its non-specific resistance (Table 7).

Table 7

Indicators of non-specific resistance in the blood of one-year-old carp infested with *Eudiplozoon nipponicum*, before and after the use of drugs, M ± m (n = 6)

| Indicators | A group of fish | | |
|---------------------------|-----------------|--------------------------|---------------------------|
| | control group | first experimental group | second experimental group |
| Lysozyme activity, % | 37.32 ± 0.209 | 38.20 ± 0.356 | 38.77 ± 0.383** |
| Bactericidal activity, % | 25.55 ± 0.229 | 26.18 ± 0.237 | 26.78 ± 0.263** |
| Phagocytic activity, % | 36.90 ± 0.262 | 37.55 ± 0.222 | 38.12 ± 0.211** |
| Phagocytic index, units. | 10.29 ± 0.153 | 10.74 ± 0.195 | 11.02 ± 0.188* |
| Phagocytic number, units. | 3.80 ± 0.080 | 4.03 ± 0.097 | 4.20 ± 0.089** |

Note: ** – P < 0.01 – compared to the control group

It should be noted that in one-year-old carp, which were treated only with “Brovermectin-granulate™”, although there was an increase in the investigated indicators of natural resistance, however, it was unreliable in all cases. With the simultaneous use of two drugs, an increase in the studied indicators was probable in all cases. Thus, the lysozyme activity of blood serum in the fish of the second experimental group compared to the control increased by 1.45 (P < 0.01), bactericidal activity by 1.23 (P < 0.01), phagocytic activity of blood neutrophils by 1, 22 % (P < 0.01), phagocytic index by 0.73 (P < 0.05) and phagocytic number by 0.40 units. (P < 0.01). A difference was found in terms of the above-mentioned indicators between yearlings of the carp of the first and second experimental groups, however, in all cases it was unreliable.

Conclusions

The use of the drug “Brovermectin-granulate™” to one-year-old white carp, silver carp and scaly carp affected by monogeneans had a stimulating effect on the resistance of their organism. At the same time, the simultaneous use of the specified drug with the immunomodulator “Avesstim™” contributed to better activation of the humoral link of non-specific immunity in sick fish.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Bozhyk, O. V., & Pukalo, P. Ja. (2012). Parazytologichna sytuacija u forelevomu gospodarstvi “Rybnyj potik” Rahivs'kogo rajonu Zakarpats'koi oblasti. *Naukovyj visnyk LNUVMBT imeni S.Z. Gzhyc'kogo*, 14, 2(52),

13–16. URL: http://nbuv.gov.ua/UJRN/nvlnu_2012_14_2%281%29_5 (in Ukrainian).
 Davydov, O. M., Lysenko, V. N., Kurovskaja, N. Ja., & Neborachek, S. I. (2013). Strategija ohrany zdorov'ja ryb v akvakul'ture. *Veterynarna medycyna Ukraïny*, 1(203), 28–30. URL: http://nbuv.gov.ua/UJRN/vetm_2013_1_10 (in Russian).
 Dzhmil', V. I. (2013). Epizootychnyj stan PrAT “Bilocerkivsil'rybgosp” shhodo urazhennja koropovyh ryb zbudnykamy invazijnyh hvorob. *Naukovyj visnyk veterynarnoi' medycyny*, 11, 57–61. URL: http://nbuv.gov.ua/UJRN/nvnm_2013_11_17 (in Ukrainian).
 Fedorovych, O.V., & Gutyj, B.V. (2019). State of the organism of the same year scaly carp infected by *Eudiplozoon nipponicum*. *Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies. Series: Veterinary sciences*, 21(94), 146–151. DOI: 10.32718/nvlvet9427
 Jevtushenko, A. V., Jevtushenko, I. D., Volovyk, T. P., & Zbozhyns'ka, O. V. (2015). Osoblyvosti cyrkuljacii' zbudnykiv osnovnyh parazytarnyh zahvorjuvan' ryb u vodojmah z riznymi gidrologichnymi rezhymamy. *Veterynarna medycyna*, 100, 167–169. URL: http://jvm.kharkov.ua/sbornik/100/8_44.pdf (in Ukrainian).
 Kofonov, K., Potrokhov, O., Hrynevych, N., Zinkovskyi, O., Khomiak, O., Dunaievska, O., Rud, O., Kutsocn, L., Chemerys, V., Gutyj, B., Fijalovych, L., Vavrysevych, J., Todoriuk, V., Leskiv, K., Husar, P., Khumynets, P. (2020). Changes in the biochemical status of common carp juveniles (*Cyprinus carpio* L.) exposed to ammonium chloride and potassium phosphate. *Ukrainian Journal of Ecology*, 10(4), 137–147. DOI: 10.15421/2020_181.

- Loboiko, Yu., Barylo, B., & Krushelnytska, O. (2017). Determination of the aminotransferase activity in tissues of infected with ectoparasites yearling carp. *Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies*, 19(79), 17–21. DOI: 10.15421/nvlvet7904.
- Lobojko, Ju. V. (2012). Urazhenist' c'ogolitok koropa ektoparazytamy Lernaea cyprinacea ta Dactylogyrus vastator u vyroshhuval'nyh stavah. *Veterynarna biotekhnologija*, 21, 286–289 (in Ukrainian).
- Prychepa, M., Hrynevych, N., Martseniuk, V., Potrokhov, O., Vodianskyi, O., Khomiak, O., Rud, O., Kytsokon, L., Sliusarenko, A., Dunaievska, O., Gutyj, B., Pukalo, P., Honcharenko, V., Yevtukh, L., Bozhyk, L., Prus, V., & Makhorin, H. (2021). Rudd (Scardinius Erythrophthalmus L., 1758) as a bioindicator of anthropogenic pollution in freshwater bodies. *Ukrainian Journal of Ecology*, 11(2), 253–260. DOI: 10.15421/2021_108.
- Vlizlo, V.V. (2012). Laboratorni metody doslidzhen u biolohii, tvarynnytstvi ta veterynarii medytsyni. Dovidnyk [za red. d. vet. n., prof., akademika NAAN V.V. Vlizla] Lviv, SPOLOM (in Ukrainian).
- Zurawski, T. H., Mousley, A., Mair, G. R., Brennan, G. P., Maule, A. G., Gelnar, M., & Halton, D.W. (2001). Immunomicroscopical observations on the nervous system of adult Eudiplozoon nipponicum (Monogenea: Diplozoidae). *International Journal for Parasitology*, 31(8), 783–792. DOI: 10.1016/S0020-7519(01)00192-8.