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PECULIARITIES OF HEAVY METAL ACCUMULATION IN FISH FROM OPEN WATER BODIES AND AQUARIUM CONDITIONS

Abstract. This research is dedicated to studying the peculiarities of heavy metal accumulation in fish inhabiting open water bodies and in aquarium conditions. The presence of all the studied heavy metals (zinc, copper, lead) was found in the muscles of the silver crucian carp *Carassius gibelio*. The analysis of the research results indicates that copper and lead levels were within permissible limits, while zinc levels significantly exceeded the standards in both experimental groups (46.5±10.9 and 129.1±69.47 mg/kg).

Keywords*: heavy metals, zinc, copper, lead, crucian carp, natural water bodies, aquarium conditions.*

Problem Statement. Heavy metals, due to their toxicity and bioaccumulation properties, are a serious environmental pollutant. Among them, lead (Pb), copper (Cu), and zinc (Zn) are of particular importance. However, it should be noted that in trace amounts, heavy metals are a natural and even necessary component of living cells, except for mercury, lead, and cadmium [1,4].

The current environmental situation requires important research on the migration of these metals in various objects to prevent their accumulation in food products and to improve the ecological situation. Although the processes of heavy metal presence in soils and plants are well studied, the impact of animal organisms on these processes remains a less explored area.

Research Object: Representatives of the carp family (silver crucian carp *Carassius gibelio*) aged 4+.

Subject: Assessment of heavy metal content in fish muscles.

Materials and Methods: The study involved forming two groups: fish from open water bodies and fish kept under aquarium conditions at the Department of Aquatic Bioresources and Aquaculture of the Dnipro State Agrarian and Economic University. Sampling for the open water group was conducted at the Sholokhov Reservoir in Dnipropetrovsk region. The fish kept in aquariums were taken from the Tarom Fish Farm JSC "Dnipropetrovsk Fish Farm" and were reared for 4 years under aquarium conditions at the department.

To determine the content of heavy metals, samples of muscle tissue were taken from fish in open water bodies and from aquarium-kept fish and sent to the "BIOSAFETY-center" laboratory. Before sampling muscle tissue, the experimental fish were weighed and measured

to form a representative sample. Sampling and material processing were carried out according to standard hydrochemical, hydrobiological, and ichthyological methods [2,3].

The concentration of heavy metals in the samples was determined by atomic absorption spectrophotometry. Initially, the fish samples were dried and ground into powder. Then, sample solutions were prepared for further analysis according to the laboratory protocol.

Research Results. Characterizing the fish from the Sholokhov Reservoir, we can say that the crucian carp exhibited relatively high size and weight indices. The study of heavy metal content showed a slight increase in zinc content in the muscles (by 16%). Other studied indicators were within the permissible limits.

The second group of fish, which participated in the study, consisted of fish that lived in the aquarium. Tap water and artificial feeds were used for their cultivation. The size and weight indices of fish in this group were significantly smaller compared to the reservoir fish. In other words, the linear growth rates lagged significantly both in mass and length. This can be explained by the relatively small size of the aquarium in which they were reared. On average, the weight of this group was 0.6 times less than that of the fish from natural water bodies, and the standard length ranged from 17.1 to 19.5 cm.

The study data revealed the actual heavy metal content in fish, which is one of the main food products for humans. Summarizing the obtained data (Table 1), we can state that fish kept for 4 years in aquariums were characterized by a higher content of heavy metals and had low growth rates compared to their peers raised in natural conditions (in the reservoir). Only in terms of lead content (0.027±0.017 mg/kg), the fish from the Sholokhov Reservoir were 0.006 mg/kg inferior to the fish from the aquarium complex. The increased lead content can be explained by its accumulation in the bottom sediments of the water bodies and the specific feeding habits of crucian carp.

Table 1

Comparative characteristics of heavy metal content by groups

No.	Heavy Metals (mg/kg)	Open Water Bodies (Sholokhov Reservoir)	Aquarium Conditions
1	Zinc	46.5±10.9	129.1±69.47
2	Copper	1.92±0.472	2.91±0.494
3	Lead	0.027±0.017	0.021±0.019

The zinc content in the aquarium fish exceeded the maximum permissible concentration by 3.2 times. We can assume that one of the sources of heavy metals entering the fish's body, which were kept in the aquarium, was artificial feed.

At the same time, the physiological norms of copper in the fish diet are still not established, so the maximum copper content was in the group of fish from the aquarium conditions, which was 0.99 mg/kg more than the other group studied.

The pH of the water plays a significant role in the mechanism of heavy metal accumulation. When the pH in the aquarium decreases (towards a more acidic environment) below 6, free metal ions quickly dissolve in water and accumulate more rapidly in the fish's body. The issue of the impact of tap water and feed on the bodies of aquarium fish remains open for further research.

Conclusion. It was found that the concentration of Cu and Pb in the muscles of fish from the Sholokhov Reservoir does not exceed the permissible limits and amounts to

1.92±0.472 and 0.027±0.017 mg/kg, respectively. The zinc content exceeded the maximum permissible concentration by only 6.5 mg/kg, which is a minor deviation from the norm.

Fish kept for over 4 years in aquarium conditions were characterized by an increased Zn content of 3.2 times. The copper content was within the norm but exceeded by 0.99 mg/kg compared to fish from natural water bodies. It was proven that fish kept in aquariums were characterized by a higher content of heavy metals and had lower growth rates compared to their peers raised in reservoirs.

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ПОРІВНЯННЯ ПОКАЗНИКІВ ОКСИНОГО СТРЕСУ, ВИКЛИКАНОГО ЦІАНОБАКТЕРІЯМИ НА СТАЦІОНАРНІЙ ТА ЕКСПОНЕНЦІАЛЬНІЙ ФАЗАХ РОСТУ

Цвітіння ціанобактерій викликає підвищений науковий інтерес через їх потенційну загрозу для водної біоти, функціонування екосистеми та несприятливий вплив на здоров’я людини. Антропогенна евтрофікація та зміна клімату є двома найвпливовішими чинниками, які обумовлюють масовість та неконтрольованість масового розмноження синьозелених водоростей (Lürling, 2017). Види ціанобактерій, що спричиняють це явище, охоплюють кілька родів: *Aphanizomenon, Dolichospermum, Microcystis, Nodularia, Planktothrix, Raphidiopsis* і *Trichodesmium*. Зазначимо, що активне і щільне цвітіння ціанобактерій спричиняє значне зниження прозорості та доступності світла іншим представникам фітопланктону та водним макрофітам. Водночас, деякі ціанобактерії, які спричиняють цвітіння, виробляють широкий спектр метаболітів, токсичних для водної біоти та людей та виділяють запахові сполуки (Codd, 2017).

Вважається, що шкідливість цвітіння ціанобактерій змінюється відносно стадії, стану і внеску токсичної субпопуляції. На початковому етапі розвитку цвітіння зазвичай демонструє низьку шкідливість, головним чином, через невелику біомасу (Mohamed, 2018). На популяційну динаміку та токсичність цвітіння, як правило, впливають чинники навколишнього середовища, зокрема метеорологічні (температурні та світлові умови), фізико-хімічні (pH, концентрація біогенних і поживних речовин) та біологічні параметри (конкуренція, активність бактерій). Вплив цих чинників проявляється шляхом взаємодії токсичних і нетоксичних популяцій та регуляції експресії генів, що відповідають за