Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(4): 979 – 986 (2024)
www.ejabf.journals.ekb.eg

Influence of Soil Macro- and Microelements on the Growth and Development of Fish

Mirtalipov Dilshat T.[1], Sadykova Dildor A.[2], Saparov Abdirahman D.[3], Jabborov Abdurashid R.[4], Imanova Dayrash N.[5], Kuzmetov Abdulakhmet R.[1*]

[1]Scientific and Technical Center and the Design Bureau and Pilot Production of the Academy of Sciences of the Republic of Uzbekistan, Tashkent
[2]Pharmaceutical Institute of Education and Research, Tashkent
[3]Nukus State Pedagogical Institute named after Ajiniyaz
[4]Samarkand State University, Samarkand
[5]International Kazakh-Turkish University named after Yassawi, Turkestan (Kazakhstan)

***Corresponding author: kuzmetov@bk.ru**

ARTICLE INFO

Article History:
Received: April 2, 2024
Accepted: June 12, 2024
Online: July 29, 2024

Keywords:
Zooplankton,
Fish,
Macroelements,
Microelements,
Electricdischarge,
Nutrition,
Mineral,
Saprolegniosis

ABSTRACT

In this article, on the basis of the Design Bureau of the Academy of Sciences of the Republic of Uzbekistan and the Scientific-technical Center of Experimental Production, the equipment for obtaining vitamin-mineral additives was developed. The technological process involved an electric discharge disintegration to transform soil components into a water-soluble state, separating macro- and microelements that can then be used as a nutritional supplement for feeding the tilapia fish. After feeding the fish weighing 3.4 grams with these elements for 3 months, they reached a weight of 160 grams and a length of 18cm (l = 16cm). The weight of the fish fed with soft feed was 120g, and the length range was (L) 13 and (l) 11cm. The difference in weight between the two experiments was 40 grams. Macro and micronutrients are important for fish development and disease resistance. It has been proven that the use of macro- and micronutrients obtained from the composition of the soil boosts the growth of fish, prevents infectious diseases, and physiologically stimulates the formation of bones and the development of muscle tissue.

INTRODUCTION

Fish farming is one of the highly profitable branches of agriculture, focused on growing certain types of fish in specially equipped artificial reservoirs. It has been shown that one of the main methods of intensifying pond fish farming, which can significantly increase the yield of fish products per unit of water area, is fish feeding. To successfully grow fish in an industrial environment, an optimal set of dietary nutrients is required, the main ones of which are proteins, fats, carbohydrates, vitamins, macro- and microelements **(Egorushkin *et al.*, 2013)**. Alongside the essential nutrients, addressing the discrepancy in productivity growth and ensuring the quality of resulting products heavily relies on correcting macro- and microelements, crucial for organizing metabolic processes and fostering organismal synthesis and development **(Ogino, 1979; Abdinazarov *et all*, 2023; Madumarov *et al*, 2024)**. It has been shown that mineral substances perform a structural function, being part of the supporting elements of the skeleton and cell membranes of all tissues. As part of various compounds, they participate in the processes of digestion and absorption, synthesis and breakdown, disinfection of toxic substances and excretion. Minerals play an important role in maintaining the colloidal state of proteins and the acid-base balance of tissue fluids, ensuring osmotic pressure and the constancy of other physicochemical properties of the internal environment of the body. Being part of biologically active compounds (enzymes, vitamins, hormones), minerals can significantly activate or inhibit metabolism. A feature of the mineral nutrition of fish is the presence of two ways for minerals to enter the fish body: with food through the mouth, and through osmotic penetration from the water through the gills and integumentary tissues. Given this characteristic of fish, studying the influence of macro- and microelements isolated from the soil became an area of interest **(Yutkin, 1986; Toporkov & Korolev, 2018)**.

MATERIALS AND METHODS

The research objects were carried out on the juvenile heat-loving fish tilapia. An electrohydraulic installation with a power of 0.5kW was used to disintegrate components and compounds in the soil suspension. It is assumed that electrohydraulic treatment promotes the transition of hard-to-reach compounds of macro- and microelements contained in the soil into a water-soluble, digestible form into an aqueous solution **(Vorobyev, 1975)**.

The technological process involved electric-discharge disintegration of soil components, transforming them into a water-soluble state. Process modes were determined, and the equipment was developed for experimental tests.

It has been ascertained that pulsed compression and tension loads ensure the opening of fused mineral particles. Under the influence of highly concentrated energy of the discharge channel, disintegration and decomposition of complex molecules of chemical compounds in the soil occurs, as well as local decomposition of a water molecule with the formation of atomic ionized hydrogen and oxygen ions. The pH value varies from 10.0 to 4.0, crossing the boundaries of alkaline and acidic environments, promoting the action of electric discharge in breaking large molecular chemical chains into lighter and water-soluble ones. All of these processes were carried out in one volume – in the discharge chamber – during the preparation of soil suspension **(Vorobyev, 1975; Vorobyev, 1979; Stepantsova *et al.*, 2018)**.

The dynamics of electric-discharge disintegration of soils is such that the destruction of particles of the source material occurs along less strong boundaries between chemically bonded grains due to their stretching and compression by pulsed loads of direct and reflected waves generated by the electric discharge **(Belov, 2018; Belov *et al.*, 2018)**.

Analysis of the results obtained showed that the most appropriate mode for soil disintegration is with a stored energy of 0.5kJ, using 200 pulses, and a specific energy consumption of 1kW·h/ kg. The technical characteristics of the EHC are as follows: productivity of not less than 3.5kg/ h, with one electrode, rated operating voltage of 50,000V, nominal stored energy of no more than 0.5kJ, total power not exceeding 1kW, average current consumption from the network at 12A, and power supply voltage of 220V.

Quantitative analysis of the main macro- and microelements in the resulting soil suspension after electrohydraulic treatment was conducted using an Avio 200 ICP-OES spectrometer. The data obtained showed that processing one kg of serozem soil in the water fraction revealed the presence of 43 different components of macro- and microelements. Their numbers are reflected in Table (1).

RESULTS AND DISCUSSION

It is known that soil contains the entire periodic table. These chemical elements are in the form of insoluble complex salts and are not available for dissolution. It has been shown that most natural complex salts are poorly soluble. Water essentially decomposes them rather than dissolves them. First, it takes away some of the salt, turning the salt into simpler compounds. Then, the rest of the molecule is simplified again by the action of water, and so on. In nature, these simplifications take tens and hundreds of years. Therefore, water has a limited content of macro- and microelements. With electro-hydraulic tillage, everything happens in a fraction of a second. In the process of research, it was discovered that during the electrohydraulic crushing of rocks and other materials, many chemical elements and their compounds included in these rocks are transferred into water in the form of soluble compounds in quantities reaching 90- 95% of their mass content in the source material. The transition of chemical elements and their compounds into an aqueous solution is explained by the fact that during an electrohydraulic treatment, the simultaneous influence and complex mechanism of all operating factors of the electrohydraulic effect lead to the rupture of sorption and peripheral chemical bonds. According to literature data, hydrobiological studies have shown that the content of macro- and microelements in water is relatively low, and the deficiency ranges from 49.9 to 56%; in the case of intensive fish farming, this percentage will be even lower.

Currently, to provide fish with minerals, inorganic chemical elements are used on an average of about 10- 15 species, which come with food, the role of other minerals is practically not ascertained. However, even this amount of minerals added to the feed is effective.

Thus, the activating effect of individual macro- and microelements on growth and metabolic processes, ascertained under production conditions, convincingly proves the possibility and feasibility of replenishing the balance of mineral compounds in fish by introducing them into the body both as part of the feed and directly from the water. In this connection, it was of interest to evaluate the influence of 43 chemical elements on the growth and development of fish. It should be noted that when the soil was treated with high-voltage electric discharges, 43 chemical elements passed into a water-soluble form and, most importantly, in the ratio that was determined by nature itself and to which the fish adapted themselves in the process of evolution.

Table 1. Content of macro and microelements in a soil sample after electrohydraulic impact

№	Name of element	Symbol	Content of mg per kg of treated soil
1	Argentum	Ag	0.45 ± 0.032
2	Arsenicum	As	0.65 ± 0.028
3	Aluminium	Al	35725.4 ±2457.4
4	Barium	Ba	124.6 ± 11.57
5	Hydrogenium	B	8.56 ± 0.67
6	Beryllium	Be	2.1 ± 0.14
7	Bismuthum	Bi	0.69 ±0.049
8	Bromum	Br	4.2 ± 0.36
9	Calcium	Ca	16802.6 ± 1258.4
10	Cadmium	Cd	0.4 ± 0.032
11	Chlorum	Cl	46.5 ± 4.57
12	Chromium	Cr	0.35 ± 0.25
13	Cuprum	Cu	36.4 ± 2.69
14	Cobaltum	Co	6.4 ± 0.58
15	Caesium	Cs	0.94 ± 0.059
16	Ferrum	Fe	24621.6 ±1856.4
17	Gallium	Ga	0.98 ± 0.085
18	Hydrargyrum	Hg	0.04 ± 0.003
19	Indium	In	0.12 ± 0.011
20	Lithium	Li	21.4 ± 1.98
21	Iodium	I	1.67 ± 0.15
22	Kalium, Calium	K	10712.4 ± 954.58
23	Magnesium	Mg	5240.3 ± 357.5
24	Manganum	Mn	68.5 ± 54.6
25	Manganesium	Mo	2.6 ± 0.17
26	Molybdaenum	Na	3524.04 ± 214.69
27	Natrium	Nb	5.2 ± 0.35
28	Niobium	Ni	31.6 ± 2.47
29	Niccolum	Pb	2.81 ± 0.14
30	Plumbum	P	852.3 ± 59.47

31	Phosphorus	Rb	8.4 ± 0.64
32	Rubidium	S	624.6 ± 54.24
33	Sulfur, Sulphur	Sb	8.64 ± 0.65
34	Stibium	Se	0.28 ± 0.15
35	Selenium	Sn	6.57 ± 0.48
36	Stannum	Sr	45.6 ± 2.95
37	Strontium	Sc	3.54 ± 0.24
38	Scandium	Ti	24.6 ± 1.47
39	Titanium	V	3.2 ± 0.21
40	Vanadium	W	6.2 ± 0.54
41	Wolframium	Y	6.8 ± 0.49
42	Yttrium	Zn	29.7 ± 1.98
43	Zincum	Zr	1.34 ± 0.11

In the 90s of the last century, the tilapia fish fry (*Oreochromis aureus*) were brought from the basin of the Smolensk Nuclear Power Plant in Russia to the Syrdarya Hydro Power Plant for acclimatization. During the 15-day period of the experiments, it was observed that the growth was very slow, and when moving to the second month, it increased rapidly **(Belozub, 1993)**.

Our experiments were carried out in two 400-liter aquariums with 25 Mozambique tilapia fish (*Mozambique tilapia*), each weighing 3.4 grams and of the same size. During the initial period of feeding, fish were noted to feed on the yolk sac and aquatic protozoa. After 30 days, the fry samples were actively swimming due to the formation of fins, and they began to eat zooplankton organisms.

Today, fish farming largely depends on imported feed and feed additives. Their high price reduces the profitability of fish farming in Uzbekistan. An effective way to improve the physiological state of fish and increase their productivity is the use of additives that have various effects on the microflora of the intestinal tract and metabolic processes.

Macroelements include: Ca, Mg, Na, K, P, S, Cl, with quantities in fish bodies varying widely and exceeding 100mg/ kg. Microelements include: Fe, Cu, Mn, Co, Se, etc., with content typically ranging from 0.01 to 90mg/ kg.

A)  B) 

Fig. 1. (A) Fish fed with the addition of macro-and micronutrients extracted from the soil (B) The tilapia fish fed exclusively with compound feed

In addition, diseases such as aeromonosis, pseudomonosis, flexibacteriosis, and fish myxobacteriosis occur in fish farms. Currently, aeromonosis is the main problem facing the carp.

Representatives of the genus *Aeromonas* are Gram-negative ubiquitous rods in the aquatic environment. The genus *Aeromonas* contains 36 different species, including the mesophilic and motile *Aeromonas* sp. They have long been recognized as major fish pathogens. They cause a variety of opportunistic infections in freshwater and marine fish, collectively known as septicemia. The main *Aeromonas* species known to cause infectious diseases in humans include *A. caviae, A. dhakensis, A. veronii* and *A. hydrophila*. *Aeromonas* are found in rivers, lakes, seawater, brackish water, irrigation water, chlorinated and non-chlorinated drinking water, groundwater, surface water and wastewater. In freshwater aquaculture, representatives of the aeromonads were isolated from the skin and bones of healthy fish, from fish feces and from the muddy bottom of reservoirs. Aeromonosis is a bacterial disease that mainly affects carp and their hybrids, as well as a number of other diseases. Currently, aeromonosis remains a serious problem in the carp pond farms. These diseases are pathogenic for marine and freshwater fish, amphibians, reptiles, and there are also variants that cause various toxic-infectious diseases in warm-blooded animals and humans.

Saprolegniosis is one of the most common fish diseases. Saprolegniosis is a secondary disease that occurs at the site of damage to the fish’s body. As a result of various injuries, saprolegniosis manifests itself as a joint disease in other diseases, both infectious and invasive.

The causative agents are fungi of the genus Saprolegnia and Achyla Aphanomyces, which are very common in nature. Almost all freshwater fish affected by saprolegniosis were affected to one degree or another or suffered unfavorable living conditions. Saprolegniosis often occurs as a result of neglect of fish in carp fish farms, aging in concrete cages, injury during fishing, loading and unloading of live fish.

The current experiments showed that a nutritious base is essential for the good growth and development of fish, and using macro- and microelements from the soil has yielded promising results.

CONCLUSION

In the experiments (20n), 3.4 grams of tilapia fish were fed with macro- and micronutrients for 3 months at a water temperature of +25 degrees Celsius. The fish reached a weight of 160 grams and lengths of 18cm (L) and 16cm (l). In contrast, fish of the same initial weight fed only with mixed feed weighed 120 grams and measured 13cm (L) and 11cm (l). The difference in weight was 40 grams. Macro- and microelements improve nutrient absorption, enhance immunity, increase stress resistance, and protect against various diseases.

Fish can actively absorb macroelements such as Ca, Mg, Na, K, P, S, and Cl from water. Therefore, their mineral needs, especially for elements like calcium and magnesium, can be largely met through osmosis, depending on the water type (fresh or salty, soft or hard). Fish constantly adjust to balance deficiencies or excesses of specific minerals present in water. The qualitative and quantitative composition of mineral salts varies in different reservoirs, affecting mineral absorption by fish and their dietary mineral requirements.

REFERENCES

Abdinazarov, X.X.; Khojamshukurov, N. A. and Madumarov, M.J. (2023). Use of Microalgae in the Production of Feed for Aquaculture. Egyptian Journal of Aquatic Biology & Fisheries, Vol. 27(3): 955 – 966.

Belov, A.A. (2018). Modelling the evaluation of the influence factors on the process of electrohydraulic water treatment. A.A. Belov//Vestnik of NGIEI.11(90):103- 112.

Belov, A.A. (2018). Planning and conducting a screening experiment to study the production of fertilisers by electrohydraulic treatment of solutions. // International technical and economic journal. 5:. 22-28.

Belov, A.A.; Musenko, A.A.; Vasiliev, A.N. and Toporkov, V.N. (2019). Justification of the device for electrohydraulic treatment of water solutions. Bulletin of agrarian science Don. Technologies, means of mechanisation and power equipment. 2(46): 23-27.

Belozub, L.K. (1993). Nutrition of blue tilapia (*Oreochromis aureus*) in the basins of Syrdarya SDPP. Modern science of zoology and scientific and methodological problems of its teaching. Proceedings of the republican scientific-practical conference. Tashkent, 24 November. 103 pp.

Egorushkin, I.O.; Kungs, J.A.; Orlenko, A.I.; Tsuglenok, N.V. and Yuryev, A.V. (2013). Application of the electrohydrodynamic effect in agriculture. Vestnik KrasSAU.1:.143-146

Madumarov, M.J.; Madumarova, S.O.; Raximov, M.Sh.; Muminova, R.N. and Abdinazarov, X.X. (2024). *Moina micrura* species in Water Bodies of Fergana Valley. Egyptian Journal of Aquatic Biology & Fisheries, Vol. 28(2): 935 – 943.

Ogino, C. (1979). Mineral requirements in fish. Proc. Zht Jap. Sov. Joint. Symp aquaculture. Tokyo. 14-18.

Stepantsova, G.E.; Nizhnikova, E.V.; Nefedova, N.P.; Vorobyev, V.I. and Lempert, O.T. (2018). Study of the influence of microelements on physiological and biochemical parameters of rainbow trout. Bulletin of Science and Education of North-West Russia, 4: 1-8

Toporkov, V.N. and Korolev, V.A. (2018). Energojeffektivnye jelektroimpul'snye tehnologii v agrotehnologicheskih sistemah. Energy-efficient electro-technologies in agricultural technolo- gy systems. Vestnik VIJESH, 2 (31):. 85-89.

Vorobyev, V. I. (1979). Microelements and their application in fish breeding. Pishch. Promst., M. – 182 pp.

Vorobyev, V.I. (1975). Microelements in fish farming. Biological role and practical application of microelements. – Riga. 117–121 pp.

Yutkin, L. A. (1986). Electrohydraulic effect and its application in industry. L.: Mashinostroenie,. - 247 pp.