Purification of surface waters in the conditions of Karakalpakstan using microscopic and high-water plants and their application in agriculture

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Abstract. The article provides information on issues related to the decrease in potable water, which is currently the most pressing, about methods of water treatment without harm to health, namely using biological methods such as water purification with the help of high and low aquatic plants, as well as information on the possibilities of reusing purified waters. Recommendations are given for the use in agriculture of biomass from aquatic plants. The main research object is the "National Water Supply Company in Karakalpakstan." Water for treatment was taken from drinking water sources. Pistia (Pistia stratiotes L.) is considered a perennial annual aquatic plant, its leaf length is 10-12 cm, and width is 6-8 cm. Lemna minor L. is relatively small, its leaves and fronds are tubular in shape, with a length of 2-4 mm and a width of 2-3 mm. Chlorella vulgaris, Lemna minor.L., and Pistia stratiotes.L. are bred in fish ponds, enzymes that counteract pathogenic microorganisms such as bacteria, viruses, and fungi are produced in water and destroy pathogenic microorganisms. Chlorella vulgaris increases oxygen content in fish ponds by 30-40%, meaning it emits 200 times more oxygen from its biomass.

1 Introduction

In the Republic of Karakalpakstan, the food base for agriculture primarily consists of dried fruits and water-based products. Water-based products are not extensively used as a food source for agricultural animals, poultry, or fish, or are underutilized. Considering the ecological fragility within our Republic of Karakalpakstan, aside from the crucial issue of purifying drinking water sources, the inefficiency of small water bodies to reach the fields is also a significant concern. In such circumstances, the utilization of increased biomass obtained through the purification of existing water sources using microfiltration and high water flow methods in agriculture becomes highly relevant. This includes both the direct

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utilization as feed for livestock, poultry, and various fish species, as well as considering its use as green fertilizer.

2 Materials and Methods

The significance of microfiltration water methods in accelerating water purification [2, 5, 6] has been well recognized. Numerous scientific works have been conducted on the introduction of water-based products [2-4, 11].

The utilization of biological ponds for purifying water sources has been known in Asian countries for almost a century. Several authors recommend the expedited use of microfiltration water from phytocenoses and high water flow sources to enhance the purification of water in biological methods [2, 3]. Moreover, a series of scientific studies have been carried out concerning the introduction of water-based organisms [2, 5].

Over the past 50-60 years, the method of purifying water in biological ponds has been widely employed. For instance, 73 settlement points in North and South Dakota in the US utilized water purification ponds [1, 2, 4], while Texas has over 200 such ponds for purification [4, 6]. Germany also extensively employs such ponds for enhancing fish populations. In California, technological institutes have conducted research for several years on the self-purification process in biological ponds [3, 4]. The method of purifying water in biological ponds is employed in Sweden, Denmark, and Australia. Some African countries, such as Cameroon and Senegal, prioritize the use of purification ponds. Russia also initiated its first experiments in purifying water in such ponds in the Lyublino fields of Moscow in 1913. These fields covered an area of 200 hectares but have since ceased operation.

Biological water purification methods are also used in various branches of industry such as alcohol distillation and brewing [2, 4, 5], [3, 5]. Water purification through biological methods poses considerable challenges in industries such as the chemical industry, oil refining, metallurgy, and coal industries [3-5]. This is primarily because water sources are typically contaminated and demand chemical treatment due to their naturally poor and often polluted conditions [4, 5, 9]. Especially in the case of water extracted from mines, chemical treatment is essential [2, 5]. Water-based products are extensively utilized in Fergana's oil refineries due to the abundance of nutrients essential for organisms [4, 6, 7, 9].

Central Asian climatic conditions allow for the efficient use of biological methods during the 9-10 month period to enhance water-based products, resulting in the purification of water by 90-98% [4, 5, 10]. The Microbiology Research Institute of the Uzbekistan Academy of Sciences has developed a biotechnology utilizing the aquatic plant Pistia (R. Stratiotes L.) to efficiently purify water in fish farms and poultry factories [4, 6, 8]. In the Republic of Karakalpakstan, under the experiment 'Karakalpak Water Supply,' water purification has been initiated utilizing biological methods. The chemical and bacteriological composition of water-based products was thoroughly examined.

High water flow organisms are considered to be aquatic plants that do not require separate cultivation and exclusive care. Pistia (Pistia stratiotes L.) is a perennial, floating aquatic plant with leaf lengths of 10-12 cm and widths of 6-8 cm. Meanwhile, Lemna (Lemna minor L.) is relatively small, with leaves and roots forming in a tufted manner, lengths of 2-4 mm, and widths of 2-3 mm. Both these organisms can proliferate substantially in natural and artificial water reservoirs. Moreover, their composition primarily consists of organic materials, mineral salts, carbohydrates, proteins, and fats. Our research in the Naiman OFY in the Takhia-Tash district found that 70% of the water-based products were significantly influenced by the multiplication of the previously mentioned high water flow organisms, thus facilitating water purification. It's proposed to utilize this purified water as a secondary source for agricultural irrigation.

Additionally, the cultivation and intensification of microscopic organisms such as Chlorella (Chlorella vulgaris) have been proposed using water-based products. Specific cultivation systems are designed for controlled proliferation in ponds, enabling the intensification of Chlorella (Chlorella vulgaris), a microscopic organism belonging to the green algae category. Water-based products are considered as food for the silver carp (Hypophthalmichthys molitrix (Valenciennes, 1844) – (NT)) and consist of 45-60% proteins, 25-30% carbohydrates, and 10% fats, along with various vitamins, antioxidants, micro and macro elements, and essential amino acids.

Enhancing the multiplication of microscopic and high water flow organisms through various methods holds significant importance in improving the ecological condition of a region, allowing for the reutilization of existing water-based products, and utilizing the generated biomass in agricultural fields.

Presently, ensuring the stability of water reservoirs, effective utilization of water resources, improving the ecological state of water reserves, preserving the biological diversity of water organisms, and their proliferation hold global importance. In recent years, the impact of anthropogenic factors on the natural environment has increased significantly, leading to a rise in ecological issues. The comprehensive organization, improvement, and sustainable utilization of water reservoirs present one of the crucial challenges of our time. Particularly, for aquaculture industries, understanding the dietary needs of fish, increasing important types of vitamins and nutrients among them, and employing them as the best possible food source for fish play a key role in enhancing fish production. The cultivation of Chlorella (Chlorella vulgaris), Lemna (Lemna minor L.), and Pistia (Pistia stratiotes L.) in fish ponds helps in reducing pathogenic microorganisms such as bacteria, fungi, and viruses through the production of enzymes and effectively eliminating these harmful microorganisms. Chlorella vulgaris increases oxygen levels by 30-40% in fish farming ponds, producing nearly 200 times more oxygen than its biomass. Furthermore, Chlorella, a natural food source for fish, grows abundantly alongside zooplankton water organisms, serving as food for fish and contributing significantly to increasing fish production.

3 Results and Discussion

Considering the ecological situation in the Republic of Karakalpakstan, the low provision of water to the population, and the poor quality of water sources in this area, addressing the issues of purifying drinking water, treating wastewater, and reusing it for various purposes is an urgent matter that needs attention throughout the entire republic. An experiment was conducted under the title 'Karakalpak Water Supply MCJSC' focusing on purifying wastewater. Samples were taken from the points of water intake and discharge, and they were chemically and bacteriologically analyzed. The results of the conducted experiment manifested themselves in the following tables, notably indicating the chemical composition of wastewater from sewage systems, table 1 specifying chemical indicators, their measurement units, and available concentrations.

The results of the table show that the chemical composition of the samples taken from the entrance and exit points of “Karakalpak water supply LIC” water supply wastewater changes positively when the pistachio plant is grown. In order to increase the productivity of fish in fish farms, it is desirable to study their feed ration, especially to breed important species rich in vitamins and proteins, and to use them as the best feed for fish. When chlorella (Chlorella vulgaris), ryska (Lemna minor.L.) and pistia (Pistia stratiotes L.) are grown in fish ponds, they produce enzymes against pathogens of water-borne infectious diseases - bacteria, fungi and viruses, and destroy pathogenic microorganisms.

Table 1. Chemical Composition of Sewage Waters from the Sewage System Showing High Contamination.

№	Chemical indicators	Unit of Measurement	Current concentration
1	Temperature	C^0	25
2	Odor	scale	2
3	Color	level	26
№	Chemical indicators	Unit of Measurement	Current concentration
4	Clarity	cm	3,5
5	Optimization Models	mg/liter	13
6	Hydrogen-based elements	mg/liter	7,0
7	Liquid oxygen	mg/liter	12,1
8	Oxidation	mg/liter	13,3
9	COD	mg/liter	161
10	BOD	mg/liter	58
11	Chloride	mg/liter	350
12	Sulfate	mg/liter	281
13	Ammoniacal nitrogen	mg/liter	1,40
14	Nitrite nitrogen	mg/liter	0,330
15	Nitrate nitrogen	mg/liter	12,2
16	Copper	mg/liter	0,03
17	Chromium	mg/liter	0,01
18	Phosphate	mg/liter	0,01
19	Iron	mg/liter	0,01
20	Mineralization	mg/liter	1840

Table 2. Information on the chemical-bacteriological analysis of “Accountable society” in the water supply systems of the 2nd, 3rd and 4th quarters provided by the “Karakalpakstan water supply” Municipal unitary enterprise “Karakalpakstan water supply accountable society" - chemical-bacteriological purification of drinking water supply.

Indicators' names	**January 2022**			**February 2022**			**March 2022**		
	Place to obtain a water sample			**Place to obtain a water sample**			**Place to obtain a water sample**		
	Entry	**Flushing**	**MPD**	**Entry**	**Flushing**	**MPD**	**Entry**	**Flushing**	**MPD**
Temperature C	13	13	-	13	13	-	16	16	-
Odor in scale	3	2	5	3	2	5	3	2	5
Colorfulness in degrees	194	48	-	214	61	-	298	63	-
Opacity, sm	0,8	2,0	-	0,8	2,5	-	1,0	2,5	-

Continuation of Table 2

Substance weight mg/dm³	281	29	30	314	28	30	248	28	30
Hydrogen ion pH measurement	8,5	7	6,5-8,5	8,5	7,5	6,5-8,5	8,5	7,5	6,5-8,5
Dissolved oxygen mg/dm³	2,2	4,2	-	2,0	6,8	-	2,0	6,4	-
Permanganate oxidation mg/dm³	21,8	10,5	-	31,2	13,8	-	29,8	18,8	-
COD mg\dm³	149	37	40	648	38	40	459	38	40
BOD – 5 mg\dm³	45	5,4	6,0	181	5,2	6,0	112	5,6	6,0
Chloride mg\dm³	410	295	350	411	318	350	459	181	350
Sulfate	248	118	590	218	121	500	418	118	500
Nitrite nitrogen mg\dm³	0,348	0,180	0,5	0,391	0,118	0,5	0,391	0,118	0,5
Nitrate nitrogen mg\dm³	10,2	6,8	25	31,3	7,2	25	28,4	6,9	25
Copper mg\dm³	0,15	0,05	1,0	0,18	0,05	1,0	0,15	0,05	1,0
Chromium - VI mg\dm³	0,12	0,04	0,1	0,15	0,04	0,1	0,14	0,07	0,1
Phosphate mg\dm³	3,0	1,8	1,9	3,1	1,0	1,0	3,1	1,0	1,0
Iron mg\dm³	0,04	0,02	0,5	0,04	0,02	0,5	0,05	0,02	0,5
Dry residue mg\dm³	3580	940	1000	3290	950	1000	3590	970	1000
Number of samples	1	1	-	1	1	-	1	1	-
TMC	68	56	-	67	58	-	189	120	-
Coliform index	2,28000	940000		2,180000	960000		2,380000	960000	

Chlorella vulgaris increases dissolved oxygen in fish ponds by 30-40%, which means, it releases 200 times more oxygen than its own biomass. In addition, chlorella, which is a natural food for fish, grows and multiplies in water bodies with zooplankton algae and feeds on them, which makes it possible to further increase the productivity of fisheries.

4 Conclusion

The conducted research includes the following aspects. In order to improve the ecological condition of the Karakalpakstan Republic, the water purification process of the Karakalpakstan water supply "Accountable society" was studied as an experimental object. Biological methods were used for purifying drinking water. The chemical (chemical-bacteriological indicators) composition of the purified water before and after the experiment on the object was studied. Based on the information obtained from the sources of pistia biomass, it is evident that the effectiveness of purification predominantly depends on the presence of fats, oils, carbohydrates, and mineral substances. Due to the organic composition of the water used for drinking purposes, it is recommended to utilize excess biomass in animal feeding without waste, especially for animals in thermal work and additional feed for livestock and poultry.

The biotechnology of purification using high-water plants has several advantages: firstly, it does not require additional resource consumption (manpower, electricity, purification equipment, disinfectants, etc.). Secondly, the funds spent on the purification of industrial enterprises and communal water are significant (manpower, electricity, purification equipment, disinfectants, etc.). Currently, most of the 624 operating farmer farms in this region are engaged in fish farming; they have the opportunity to purchase pistia, chlorella, and rye grass for purification, as well as the funds used for industrial enterprises and communal water purification (manpower, electricity, purification equipment, disinfectants, etc.); thirdly, the biogas obtained from the biomass of high-water plants can be used as an alternative energy source; fourthly, in the purification process, water purified with high-water plants can be used for watering industrial plants, in agricultural plantings, or reused by industrial enterprises.

Authors' contribution

Sh. Yakubjonova and H. Khaydarova prepared the manuscript, executed the study, and interpreted the study; S.Yuldasheva, S.Rustamova, B. Ishmuminov contributed to the concept and study design.

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