Study of biological treatment of domestic and municipal wastewater using microscopic algae

M. N. Abdukadirova*, *B. Sh.* Ismailxo'jaev, and *K. B.* Abdukadirova

"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University, Tashkent, Uzbekistan

Abstract. The article presents the results of research on improving the technology of biological treatment of domestic and municipal wastewater by microscopic algae at the Bektemir treatment plant in Tashkent. Growth, development, yield and hydro - chemical composition of water by growing algae at concentrations (50, 75, 100%) and the effectiveness of biological treatment of wastewater in a semi-finished device have been studied.

1 Introduction

Is known that the Earth consumes 3300 - 3500 km^3 of water per year, and the demand for water is growing every year. This is due to the expansion of cities, the rapid development of industry and agriculture, the expansion of irrigated lands, population growth and the improvement of their living conditions, and other factors that complicate the problem of water supply to mankind. As a result, a quarter of the world's population now lives in countries with drinking water shortages. Such a situation is very noticeable in a number of African countries, in the Middle East, and even in developed European countries. The above-mentioned negative developments have not bypassed the Republic of Uzbekistan, and this problem is getting worse every year. One of the factors in its prevention and elimination is the conservation of water resources, reuse of used water and improvement of water resources protection measures [1-3].

It is known that one of the main tasks of efficient use and protection of water resources is the treatment of industrial enterprises, agricultural production and utilities for various purposes, especially the biological treatment of urban wastewater [4-6].

The most important sources of water pollution are industrial and municipal wastewater. These effluents contain various substances that are dangerous to living organisms, which contaminate the effluents with lakes and reservoirs [6-8].

Currently, some of the used water is treated and the rest (50%) is discharged into the reservoirs without being completely treated. One of the main ways to prevent such negative consequences, ie to keep the hygienic condition of water bodies clean, is to build various wastewater treatment plants, apply modern methods, develop a scientific basis for the reuse of treated wastewater [5, 9, 10].

Based on the above data, biological treatment of domestic wastewater has been poorly studied, in particular, no research has been conducted to reduce the treatment time and

*Corresponding author: iscmmstiai2022@gmail.com

increase the level of treatment using aquatic plants. With this in mind, we plan to conduct research to improve the technology of biological treatment of domestic and municipal wastewater generated from the aeration station "Bektemir" in Bektemir district of Tashkent.

2 Materials and methods

The object of study was the aeration station "Bektemir", due to the fact that 3 out of 4 existing stations in the city carried out scientific work on wastewater treatment, and the effluent of this aeration station was not studied at all. “The design capacity of the Bektemir sewage treatment plant is 25,000 cubic meters, and currently it processes 18,000-21,000 cubic meters of wastewater. 70-80% of it is industrial water , the rest is domestic water. The enterprise can operate in normal mode only if the share of industrial water in the working water is less than 25-30%.

A total of 30 samples of microscopic algae in water basins located in the Bektemir district of Tashkent were collected from water sources, depending on the season. Collected samples were identified under a microscope after a certain period of time and strains.

It was found that the composition of algae distributed in water sources in different regions varies. This is due to the diversity of dissolved nutrients in the water of reservoirs, temperature, Variety of light intensity, water flow velocity, and geographical location of water sources, the presence of anthropogenic factors that positively and negatively affect the spread and development of algae. Determination of the species composition of algae was carried out by the method under the leadership and participation of Prof. Alimjanova (Gollerbach et al. 1953), a leading researcher of the Institute of Flora and Fauna of the Uzbek Academy of Sciences [8, 13, 14].

3 Results and Discussion

Research has shown that all wastewater generated at the Bektemir aeration station is discharged from multi-storey residential buildings in Bektemir district and discharged to the Bektemir aeration station through central pipes. At the Bektemir treatment plant, wastewater is treated mainly by mechanical and biological methods. Mechanically, the effluent is treated in the following facilities: grate, grinder, sand trap with mechanical cleaner (with horizontal-looking

hydraulic elevator) and primary radial clarifiers. After the wastewater is treated according to the above system , the biochemical demand for oxygen in the floating suspended solids in them is reduced by 10-20% to 40-50%, and the wastewater treatment efficiency is about 35-40%. Wastewater treated at this level is sent to biological treatment facilities. The structure consists mainly of an aeration tank and a secondary radial-type sediment, through which the organic matter in the effluent is partially mineralized under the influence of active "il". Due to this, the biochemical demand for oxygen in wastewater is reduced (60%) and floating suspended solids are reduced to 50%. The efficiency of wastewater treatment through this process is on average 55-60%. This level of treated wastewater is treated with chlorine in wells with a diameter of 2500 mm and discharged into the Chirchik River. The chemical composition of the water basins from which algae samples were taken was analyzed in relation to the season. The results showed that the accumulation of the necessary biogenic elements - nitrogen, phosphorus, calcium - was high in summer and autumn (Table 1).

Table 1. Changes in the chemical composition of water bodies in the Bektemir district of Tashkent compared to the season (average).

Hydrochemical	Substances	amount	(mg / l)	
Parameters	Spring	Summer	Autumn	Winter
Suspended substances	102	18.5	8.5	29.3
pH	7.4	7.8	7.0	6.9
Dry residue	1200	1100	12.00	1266
(HCO_3) hydrocarbonate	105	144	158	180
(SO_4)sulfate	450	585	736	685
(HCl) chloride	60	8.4	98	136
(Ca) kalwiy	95	115	161	145
(Mg) magnesium	93	80	100	110
(Na) sodium	85	100	180	130
(K) potassium	2.1	2.3	1.0	2
(N) total nitrogen	8.5	12.8	8.5	5.9
P_2O_5	1.5	2.9	2.5	1.8

We know that every plant needs nutrients to grow, develop and bear fruit.

If a certain amount of nutrients is not provided or if there is a lack of any essential elements for life, slow their development, the plant may not grow well or suffer from a specific disease.

It is known that in order to determine the effectiveness of algae used in the process of biological treatment of various wastewater, it is necessary to test them first in the laboratory. With this in mind, we selected Chlorella vulgarius B-1 1 and Scenedesmus obliquus UA-2-7, the most common strains of chlorella vulgarius isolated in the Bektemir region, from several strains isolated in pure algal form. These algae are distinguished by their resistance to various environmental conditions when stored in the laboratory and in early experiments. We performed algae cultivation in 500 ml glass flasks located in a device that automatically controlled the growth factors (temperature, light intensity) in the

laboratory. At the same time, we increased the growth of algae in a nutrient medium with

50.75,100% wastewater in several different variants. As a control option, we obtained the standard mineral nutrient medium Tamiya. Every 3 days after the start of the experiment, we observed the morphological status and size of algae cells under a microscope in Goryaev's chamber and counted their number of cells. The results of the study showed (Table 2-3) the effluent at different concentrations differs in the aqueous variants. If the number of cells in the nutrient medium with Chlorella vulgaris 50% was 38 million / ml in 8 days, the number of algae cells grown in 75 and 100% wastewater was 33 and 28 million, Scenedesmus obliquus 50%. while the number of cells in the aqueous nutrient medium reached 18 million / ml in 8 days, while the number of algae cells grown in the 75 and 100% wastewater medium was 15 and 8 million, respectively. This was because the algae

had not yet adapted to the sewage conditions. Therefore, algae did not reproduce well, especially in the first 4 days. Significant changes also took place in the morphological state of the cells. For example, In a nutrient medium with 75% wastewater, especially in a medium with 100% wastewater, the size of algae cells decreased and the shape of cell organelles changed. This condition continued until 6 days of growth, after which the cells slowly began to recover after adapting to these conditions. [19-26]

Received research results that showed (Table 2), Bektemir stream waters cleaning in construction cleaning activity as a result released stream water contained in substances

water herbs growth in the process noticeable degree assimilation water hydrochemical from see possible. Water herbs above in options when grown productivity both kind of options sequence depending on Chlorella vulgaris B-1 1.7-2.2 g/l (control variant 2.4 g/l), Scenedesmus obliquus UA-2-7 7 0.9-1.6 g/l (control variant 2.1 g/l) formed made (dry substances account). Chlorella vulgari , Scenedesmus obliquus household - communal stream waters cleaning promising strain b die it _ biological cleaning in the process to use recommended reach possible. These account received without this water wood stream waters cleaning efficiency we found out.

Tashkent city Bektemir in the district Bektemir stream waters cleaning in construction in the basins growing water herbs from within stream waters cleaning use in order to household – communal stream water from the source Chlorella vulgaris B-1 and Scenedesmus obliquus UA-2-7 wood disconnect we got These so stream to water flexibility high that showed. We know that there are indicators that determine the quality of any water, including wastewater, and only when they are analyzed will it be possible to assess water quality. These range from the smell of water to the dry matter, chlorine, phosphorus, sulfate ions and nitrogen. In particular, one of the most desirable indicators of water is the reduction of the amount required in the biochemical process in water. Chemical analysis showed that (Table 2-3) Chlorella vulgaris B-1 algae had significantly higher levels of suspended solids, dry residue, hydrocarbons, sulfates, nitrogen, phosphate. We can see that the above water levels have decreased significantly after the algae were grown. In this case, the nutrients nitrogen and phosphate are not present in the wastewater at all.

Table 2. Hydrochemical composition of sewage before Chlorella vulgaris B -1 algae

№	Options	Smell ball	pH	Suspended item, mg/l	Dry matter mg/l	Hydrocarbonate (HCO_3), mg/l
1	Ozone medium with 50% wastewater	3	7.5	100 ±4.0	200 ±5.0	150 ±4.5
2	Ozone medium with 75% wastewater	4	7.5	150 ±6.0	300 ±7.5	220 ±6.6
3	Ozone medium with 100% wastewater	5	7.4	200 ±8.0	400 ±10.0	300 ±9.0

Continuation of table № 2

№	Options	Chlorine (Cl) mg/l	Sulfate (SO_4)mg/l	General Nitrogen (N) mg/l	Phosphate (P_2O_5) mg / l	BPK_5 mg /O_2/l
1	Ozone medium with 50% wastewater	20 ±0.8	75 ±3.5	4.6 ±0.2	10±0.4	80 ±3.0
2	Ozone medium with 75% wastewater	30 ±1.2	110±5.0	6.7±0.3	15 ±0.7	120 ±5.5
3	Ozone medium with 100% wastewater	40 ±1.5	150 ±6.0	9.1 ±0.4	20 ±0.9	160 ±7.5

Table 3. Hydrochemical composition of wastewater after cultivation of Chlorella vulgaris B -1 algae

№	Options	Smell ball	pH	Suspended item, mg/l	Dry matter mg/l	Hydrocarbonate (HCO_3) mg/l
1	Ozone medium with 50% wastewater	1	8	9 ±0.3	100 ±4.0	90 ±4.0
2	Ozone medium with 75% wastewater	1	7.9	12 ±0.45	150 ±6.0	110 ±4.8
3	Ozone medium with 100% wastewater	2	7.8	15 ±0.6	200 ±9.5	220 ±8.8

Continuation of table № 3

№	Options	Chlorine (Cl) mg/l	Sulfate (SO_4)mg/l	General Nitrogen (N) mg/l	Phosphate (P_2O_5) mg / l	BPK_5 mg /O_2/l
1	Ozone medium with 50% wastewater	18 ±0.8	45 ±2.0	0	0	3.5 ±0.1
2	Ozone medium with 75% wastewater	26 ±1.1	75±2.9	1.1±0.05	2 ±0.7	120 ±5.5
3	Ozone medium with 100% wastewater	38 ±1.5	110 ±3.5	2.5 ±0.1	8 ±0.28	160 ±7.5

When we determined the amount of elements in water bodies, we identified several important indicators. In this case, we paid special attention to the total nitrogen, phosphorus oxide, potassium, magnesium, sodium, calcium, dry matter, the number of hydrogen ions, and so on.

However, it was found that the amount of these elements also varies with the season of the year. For example, it was proved that the amount of dissolved elements is the highest in the summer, then in the fall and spring, and in the winter, the minimum. For example, nitrogen content is 12.8-8.5-8.5 5.9 mg / l (respectively). It should be noted that the high content of nitrogen in the Bektemir district of Tashkent creates conditions for the spread of algae in the summer and autumn months. Algae species (especially green and blue-green) were also observed to be more common during these months [15,17,18].

4 Conclusions

1. The composition of algae for use in the biological treatment of domestic wastewater at the Bektemir treatment plant was studied depending on the season of the year, and it was found that the representatives of the department of green algae are widespread.
2. Chlorella vulgaris B-1 and Scenedesmus obliquus UA-2-7 strains were found to be resistant to these conditions, with little change in growth and development compared to the control option.
3. Chlorella vulgaris B-1 strain was observed in the laboratory when grown in different concentrations of wastewater. The number of cells, the degree of purification of

the yield was higher when grown in the variant with a concentration of 50%.

4. It turns out that the efficiency of biological treatment of wastewater from the Bektemir treatment plant with the help of chlorella algae in a semi-finished plant can be increased to 90-92%.

References

1. Matamoros Víctor, Uggetti Enrica, García Joan, Bayona Josep M.(2016) / Assessment of the mechanisms involved in the removal of emerging contaminants by microalgae from wastewater: a laboratory scale study // J. Hazardous Mater. [Electronic resource]. pp.97-205.
2. Temnov M.S., Markin I.V., Santalov R.D., Bushkovskaya A.I., Yeskova M.A. (2017) / (Saratov City, Pugachevskaya Str., 117-50) /Kinetics of consumption of phosphate anions and ammonium cations by microalgae from municipal wastewater// Innovations in food technology, biotechnology and chemistry: Materials of the International Scientific and Practical Conference, Saratov, pp. 207-209.
3. Dickinson K. E., Bjornsson W. J., Garrison L. L., Whitney C. G., Park K. C., Banskota A. H., Mcginn P. J. (2015) / Simultaneous remediation of nutrients from liquid anaerobic digestate and municipal wastewater by the microalga Scenedesmus sp. AMDD grown in continuous chemostats// J. Appl. Microbiol. [[Electronic resource]]. – pp. 75-83.
4. Otto Benjamin, Schlosser Dietmar (2014) / First laccase in green algae: purification and characterization of an extracellular phenol oxidase from Tetracystis aeria// Planta. – pp. 1225-1236.
5. Kazmiruk V.D., Kazmiruk T.N. (2015) / Water purification by phytechnology methods (125040, Moscow, Bumajniy Dr., 14. C2 (6th Floor), selhozizdat@mail.ru // Water Treatment [Electronic resource]. pp.66-70.
6. Sotnikov A.B., Balimova E.S. (2016) / Biological wastewater treatment for the production of Thiokol sealants / (Kazan, Akademicheskaya Str., 2) // 15th International Conference of Young Scientists "Food Technologies and Biotechnologies", Kazan, 13-14 April, Compilation of conference materials. – Kazan, pp. 240-242.
7. Khabibrakhmanova A.I., Yugina N.A., Khabibrakhmanov V.Z., Shulaev M.V. (2016) / Biological wastewater treatment from copper ions / (Kazan, Akademicheskaya Str., 2) // 15th International Conference of Young Scientists "Food Technologies and Biotechnologies", Kazan, Compilation of conference materials. – Kazan, pp. 250-252.
8. Ecology and Occupational Safety and Health (2013) / Biological treatment of industrial wastewater // – pp. 38-41.
9. Bolshakov N.Yu (2013) / Deep biological treatment of urban wastewater from phosphorus /. // Ecological Reference pp. 14-19.
10. Pupirev E.I., Shelomkov A.S. (2014) / Economic case for environmentally safe wastewater treatment technologies // BCT: Water Supply and Sanitary Engineering – pp. 5-13.
11. Turdialieva Kh., Shoyakubov R.Sh. (2005) / Biological wastewater treatment of the “Suvoqava” Production Administration of Angren by cultivating higher aquatic plants and algae. Uzbek Biological Journal. Tashkent. Pp. 54-59.
12. Khaydarova Kh.N. (1991) / Pistia Straliotes and its use in biological wastewater treatment of kenaf primary processing plants: Abstract of dissertation. Candidate of Biological Science. Tashkent. IB, pp. 46.

13. Nechaev V., Chen Yuangao, Dai Suanyui, Pi Yuy, Chjan Khan (1991) /. Investigation of the conditions for the growth of aqueous hyacinth in silver-containing wastewater and determination of the limit of its harmless silver content in such waters. J. Ecol pp. 30-35.
14. Shoyakubov R. (2009) / "Biotechnology of treatment of wastewater of agricultural and industrial enterprises with aquatic plants and algae". Tashkent. 2008. Page 143.
15. Ergashev A., Otaboev Sh., Sharipov R., Ergashev T. Ecological significance of water in human life. Tashkent. "Science" pp. 536.
16. Kholmatov U.A., Khidirboeva G. (2015) / Selection of biological objects for treatment of domestic and municipal sewage. XIV traditional scientific-practical conference on "Modern problems of agriculture and water resources". Part I. pp. 9-10. Tashkent Institute of Irrigation and Land Reclamation. pp. 125.
17. Kudratov O. (2003) /"Ecology of Industry" Tashkent. pp. 145.
18. Kulmurodov B., Ismailkhadjaev B., Khalmirzaeva B. (2004) / Bioecological features of promising types of microalgae. Materials of the International scientific - practical conference "Ecology Problems of Kazakhstan". Chimkent. pp.171-173.
19. Ismailkhadjaev B.Sh., Smanova Z., Yangibaev A. (2009) / Immobilized reagents for the determination of toxic heavy metals in water of various nature. Collection of reports of the Republican scientific-practical conference on Problems of training highly qualified personnel for agriculture and water industry. pp.16-19.
20. Shoyakubov R., Nigmatiy S. (2009) / About the possibilities of using some higher aquatic plants in the wastewater treatment of textile enterprises of Turkey. Materials of the International Conference Actual problems of modern algology, mycology and hydro botany, pp. 283-285.
21. Lurye Yu. (1986) / Handbook of Analytical Chemistry. Moscow.: Chemistry pp. 256.
22. Kutliev D.K. (1993) / Microorganisms of industrial and agricultural wastewater in Uzbekistan and their cleaning role. Abstract of Doctor's Dissertation. Tashkent. pp. 45.
23. Ismailkhadjaev B.Sh., Kholmirzaeva B. (2009) / A set of International scientific-practical conference references on "Biochemical properties of algae grown in Uzbekistan and their practical application" and "Actual problems of algae, mycology and hydro-botany". pp.92-96.
24. Buriev S.B., Mustafoeva M.I., Jumaeva M.A. (2004) / Influence of dye and chlorine used in textile enterprises on the aquatic algae. The development of botanical science in Central Asia and its integration into production. pp.248-249.
25. Shoyakubov R.Sh., Kholmuroov A.G., Kutliev J., Khaydarova Kh.N., Khasanov O., Jumaniyazova G.I. (1993) / Recommendations for effective biotechnology for wastewater treatment using Pistia Straliotes . pp. 30.
26. Shoyakubov R.Sh. (1993) / Biology of the Pistia Straliotes and the possibility of its practical use: Abstract of dissertation. Candidate of Biological Science. pp. 46.