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Bioremediation of Chromium Based on Macrophytes

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A B S T R A C T

No research has yet been conducted in the field of wastewater treatment of tanneries containing a high concentration of chromium biologically using high algae in the Republic of Uzbekistan.That is why the treatment of wastewater from tanneries as well as waters purified by physico-chemical way requires adaptation of biological purification and has great scientific, practical and environmental significance.This article examines the tolerance of high algae, namely *Azolla caroliniana*, adapted to chrome-plated water in concentrations up to 30%, under artificial conditions, in polluted Artisian waters with different concentrations of chromium, as well as with the addition of wastewater from enterprises. In 5 days, the photosynthesis of the *Azolla caroliniana* culture adapted to chrome-plated wastewater (30%) was restored to 50-80 %. During the entire time of growing *Azolla caroliniana* (7 days), there was a three-fold increase in culture than at the beginning of the experiment, and the reproduction rate reached 78.4-82.6%During the study, the level of tolerance of *Azolla caroliniana* to chromium was considered. As a result of the data obtained, an increase in *Azolla caroliniana* algae tolerant to wastewater contaminated with chromium (30%) was recorded by 3 times on the 7th day of the experiment. On the 5th day of the experiment, the photosynthesis of *Azolla caroliniana* was restored to 50-80%, and the reproduction of the culture reached 78.4-82.6%. As a result, the wastewater was purified from chromium from 4.87 mg/l to 2.34 mg/l.According to the obtained results, sorption of chromium by *Azolla caroliniana* gives averages 0.56-1.09mg/g relative to the dry mass.

Keywords

Bioremediation, chromium, macrophytes, *Azolla caroliniana* Willd., *Lemna minor* L., *Pistia stratiotes* L., *Eichhornia crassipes* Solms

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Introduction

With rapid population growth, urbanization and an accelerated pace of industrialization over the past decades, water resources have been severely polluted (SRWS, 2008). The high rate of pollution of water and aquatic ecosystems in general, requires rapid, environmentally friendly and cost-effective restoration. It is worth noting that industries such as textile, printing, electroplating, oil, metallurgy and pharmaceuticals consume huge amounts of water and organic chemicals. The admixture of chemicals and toxins in the composition of these wastewater from enterprises will certainly cause significant harm to the environment when they are discharged into various water bodies (rivers, canals and lakes), and are also of particular concern in developed countries such as Uzbekistan (Khujamshukurov *et al.,* 2016; Abdinazarov *et al.,* 2019). In more developed countries, this problem has a rational solution: all the factors and consequences of industrialization are taken into account and systematically solved with the help of improved wastewater treatment methods. But it is worth noting the fact that not all countries of the world have technological know-how, systematic implementation of environmental policies and stable financial resources, which has led to the emergence of larger environmental problems.

Particular attention among water pollutants is attracted by heavy metals, which are characterized by persistence and bioaccumulation (Rai *et al.,* 1981; Lokeshwari and Chandrappa, 2007; Chang *et al.,* 2009; Yudav *et al.,* 2009). At this stage of development, mankind began to understand how important and necessary it is to maintain the balance and purity of the surrounding world. For this reason, the attention of ecologists and scientists of the world has increasingly begun to attract the problem of aquatic ecosystems. Should be noted that today there is a growing need for affordable and environmentally friendly wastewater treatment technology from chemicals, toxins and heavy metals, thereby processing water and improving its quality. Currently, much attention is paid to the pollution of wastewater with chromium.

However, chromium is used as one of the main tools in leather processing, metal preparation and polishing. Several forms of chromium are found in scientific sources, such as Cr(II), Cr(III) and Cr(VI), depending on the oxidation state. It should be noted that the valence form of Cr(VI) is 500 times more harmful and carcinogenic than the Cr(III) form and has a significant effect on the human body. Phytomeditation meets all criteria and offers a rational solution. Among them, *Azolla caroliniana* is a fast-growing, free-floating and nitrogen-determining fern (Brooks and Robinson, 1998; Cheng, 2003; Prasad and Freitas, 2003; Suresh and Ravishankar, 2004; Srivastva *et al.,* 2008; Dhir *et al.,* 2009a; Dhote and Dixit, 2009; Marques *et al.,* 2009; Rai, 2009, Sh. Azimov *et al.,* 2022). It has been described as an excellent candidate for the filtration of heavy metals from industrial wastewater (Arera *et al.,* 2006; Umali *et al.,* 2006). Scientists of Uzbekistan A. M. Muzaffarov, T. T. Taubaev, M. Abdiev. Dj. K. Kutliev, R. Sh. Shayokubov, S. B. Buriev, H. Berdikulov, S. Khojjiev, T. N. Kholmuradova, D. A. Mirzaeva (Mirzaeva *et al.,* l, 2020a) conducted scientific research under purification of wastewater on the basis of high algae from different salts, pesticides, heavy metals and radiation metals and made a significant contribution to the development of the industry.

And they also introduced research into the classification of higher algae, the technical parameters of their cultivation, the establishment of the physicochemical composition of macrophytes, biological fertilizers from higher algae in agriculture, feed production, oil and gas processing and storage, oil and gas farms, poultry farms, as well as the development of biological technologies wastewater treatment (Khujamshukurov *et al.,* 2011; Mirzaeva *et al.,* 2020b; Abdinazarov *et al.,* 2018 and Shakirova *et al.,* 2021).

However, studies on the biological treatment of high chromium (Cr) tanneries wastewater based on algae have not been conducted.

Therefore, it is important to combine the biological treatment of wastewater from tanneries with physical and chemical methods.

The purpose of the work

Study of the role of macrophytes in the process of bioremediation purification from chromium (Cr) from technical wastewater from tanneries.

Materials and Methods

Higher algae (*Azolla caroliniana* Willd., *Lemna minor* L., *Pistia stratiotes* L., *Eichhornia crassipes* Solms.) and chromium (Cr) wastewater from a tannery were chosen as objects of study.

The retention parameters of chromium in water were determined by atomic spectroscopy (GOST 31956, 2012, Method for determining the elemental composition of natural mine waters by ICP-MS).

The calculation of the statistical error, mean, confidence intervals, and standard deviations from the experimental data was performed using the computer program STATISTICA 6.0 and standard methods. The statistical significance of the results was determined using Student's t-test.

The work was carried out on the basis of the Department of Biotechnology of the Tashkent Institute of Chemical Technology, Uzbekistan.

Results and Discussion

The article is devoted to the study of the process of purification of wastewater from tanneries from chromium and other chemicals using high algae based on modern scientific and technical knowledge. In particular, the sensitivity of higher algae to chromium, which was identified as the main object of study, was studied (Fig. 1).

Study showed the resistance of macrophytes to chromium in the amount of 1.0 mg/l *Azolla caroliniana* on the 2-7th day of cultivation was 86.7%; 42.1%; 27.1% and 6.32%, respectively, viable. Compared to control 1, it showed a decrease of 12% on the second day of growth and 26.1% on the 7th day of growth. It was found that over the same period, the survival rate of duckweed was 3.21% at 5 days of growth compared with other macrophytes. On the 7th day of observation, it was noted that the culture was completely necrotic, the roots began to rot. *Lemna minor*, *Pistia stratiotes* and *Eichhornia crassipes* were completely necrotic on the 7th day of observation, while *Azolla caroliniana* was completely necrotic on the 10th observation day. During the study, it was noted that *Azolla caroliniana* had a relative resistance among macrophytes in terms of resistance to chromium (1.0 mg/l).

Therefore, *Azolla caroliniana* was selected as the main object for further research. In subsequent studies, the development rate of A. caroliniana was studied in fresh water without a nutrient medium at a high chromium content (Fig. 2).

According to the obtained results, with an increase of the concentration of chromium, the growth rate *Azolla caroliniana* begin decrease ((mg / l)) 0,5→0,87%, 1,0→0,68%, 1,5→0,59%, 2,0→0,50%, 2,5→0,46%, 3,0→039%) and biomass correlations.

In particular, on the 10th day of growth at a concentration of 0.5 mg/l, 1150.9 g of biomass per 1 m^2 was formed, and at a concentration of 3.0 mg/l - only 1.79 g of biomass.

An interesting aspect of the study was the very low biomass with a survival rate of 0.52%. The reason for this was the use of tap water in the culture medium and the addition of a certain amount of chromium. The tolerance of *Azolla caroliniana* to high concentrations of chromium and its sorption properties for chromium can be explained by the absence of macro-, microelements and mineral salts in the nutrient medium.

In our next study, the chromium uptake rates from the wastewater containing chromium with different concentrations of *Azolla caroliniana* were analyzed (Fig. 3).

According to the results, the initial condition of the experimental options section was 4.37 mg / l on the 3rd day of growth of chromium-containing wastewater with an average of 4.87 mg / l, an average of 3.81 mg / l on the 7th day, and 3.34 mg / l on the 10th day, and on day 14 it was found to decrease to 2.34 mg / l.

Table.1

Elements	Weight, %	σweight,%
O	39,41	0,43
Na	23,20	0,28
Mg	6,55	0,17
Si	0,50	0,08
S	12,41	0,21
Cl	14,53	0,23
Ca	2,85	0,14
Cr	0,56	0,16
Total:	100,0	

Table.2

Elements	Weight, %	σ weight,%
O	38.36	0.83
Na	23.13	0.54
Mg	6.27	0.33
Si	0.69	0.15
S	10.13	0.37
Cl	17.45	0.48
Ca	2.87	0.27
Cr	1.09	0.30
Total:	100.00	

Table.3

Element	Weight, %	σ weight,%
O	43.29	0.92
Na	27.92	0.70
Mg	1.36	0.26
S	25.76	0.67
Cl	1.67	0.28
Total:	100.00	

Table.4

Elements	Weight, %	σ weight, %
O	9.36	0.83
Na	36.72	0.64
Mg	0.85	0.23
S	5.38	0.30
Cl	47.69	0.72
Total:	100.00	

Fig.1 Tolerance of macrophytes to chromium (6^+) (1.0 mg / l)

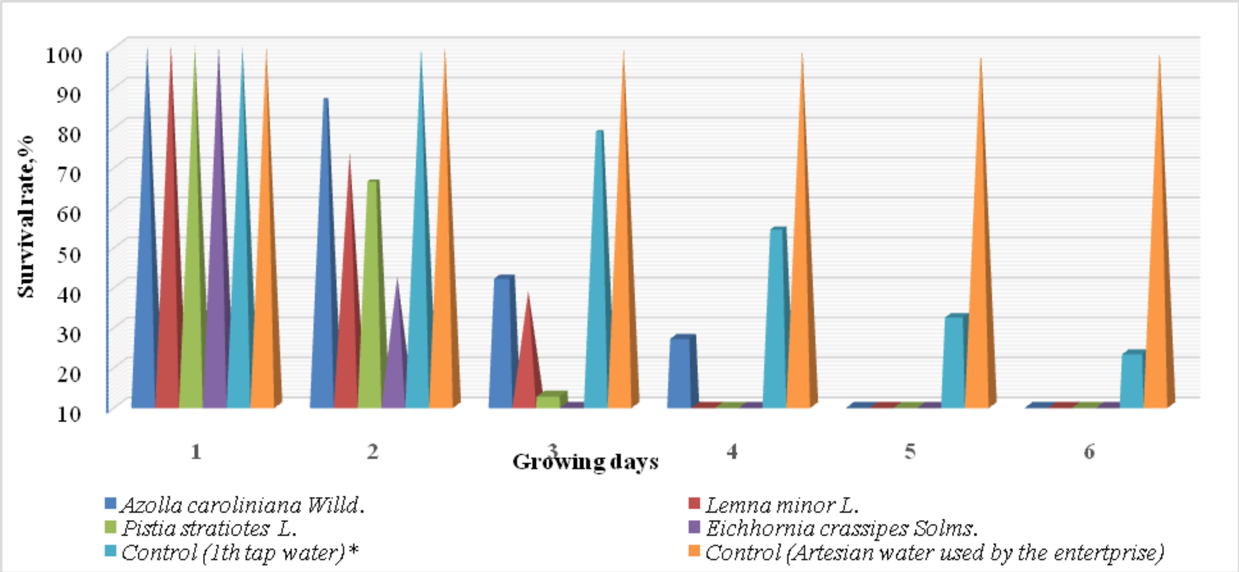


Fig.2 Viability of *A.caroliniana* in chromium on various concentrations %

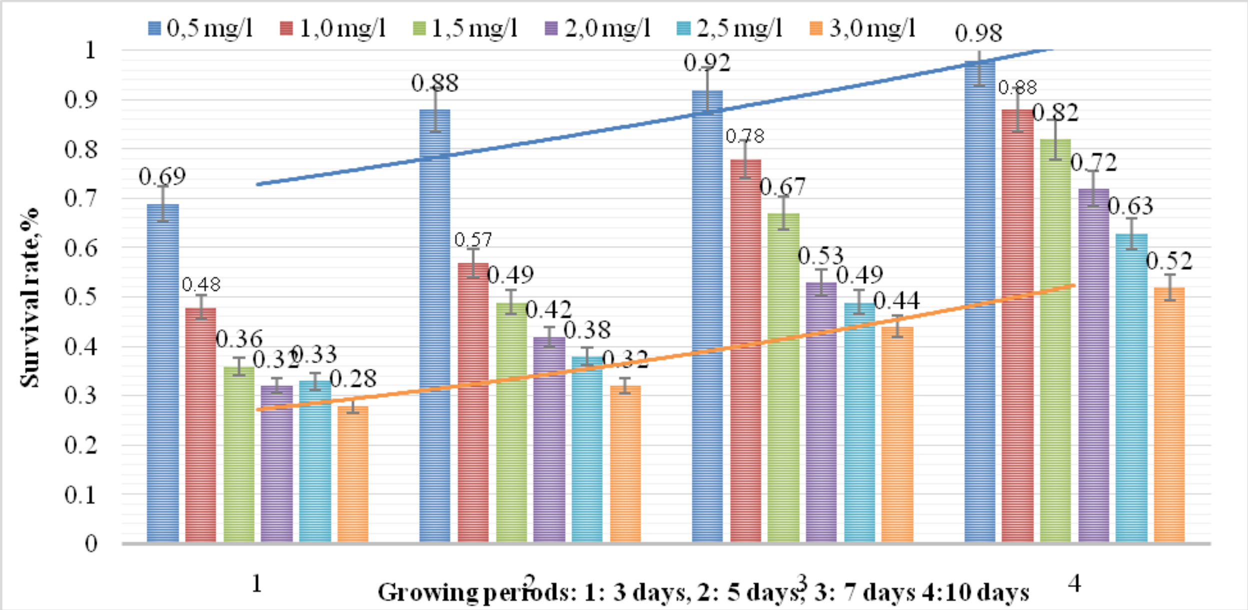
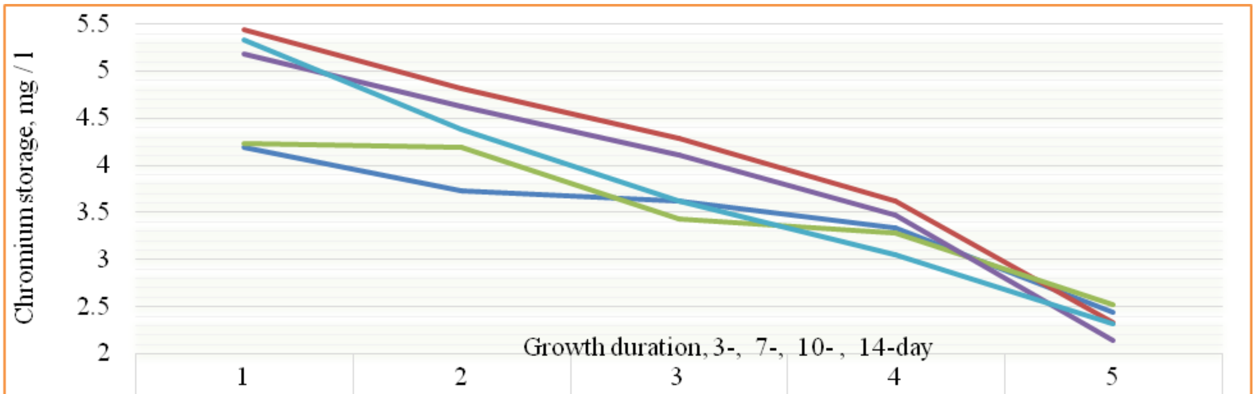
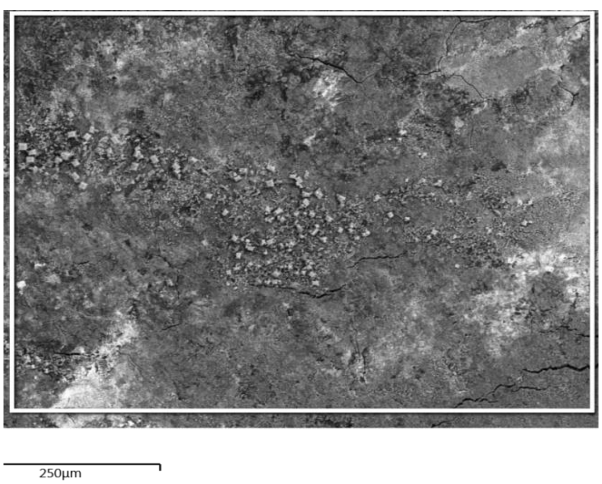


Fig.3 Assimilation of chromium in wastewater by *Azolla caroliniana.*



	1	2	3	4	5
1	4.18	3.72	3.61	3.33	2.43
2	5.43	4.81	4.28	3.62	2.32
3	4.23	4.18	3.42	3.27	2.51
4	5.17	4.62	4.11	3.46	2.14
5	5.32	4.37	3.62	3.04	2.31

Fig.4 Chromium storage of *Azolla caroliniana* biomass grown for 10 days, mg / g



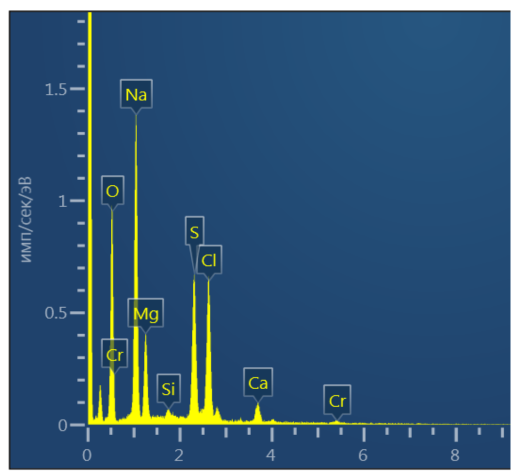


Fig.5 Chromium storage of *Azolla caroliniana* biomass grown for 14 days, mg/g

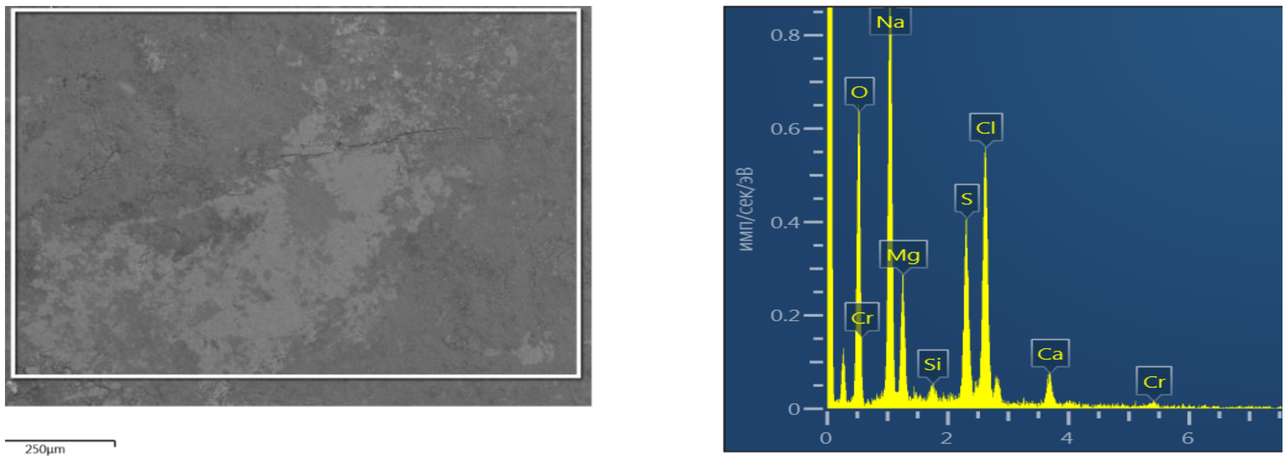


Fig.6 Storage of mineral salts of *Azolla caroliniana* biomass grown for 10 days, mg/g

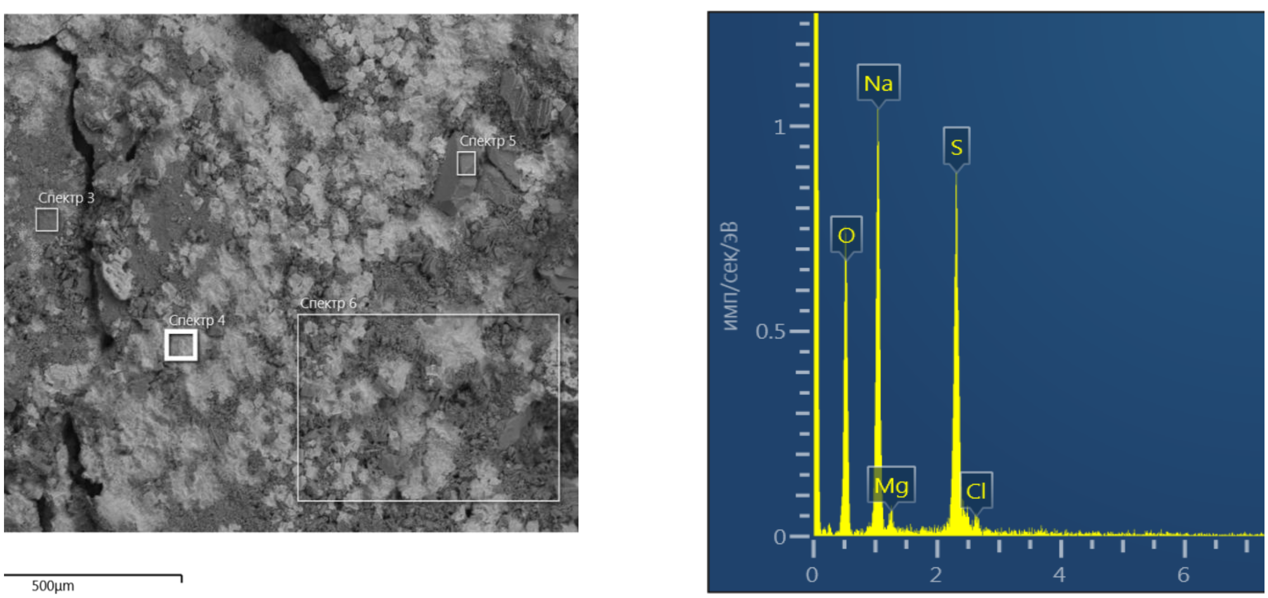
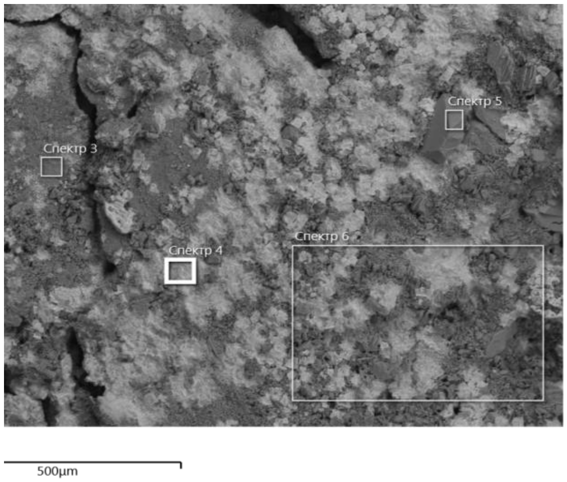
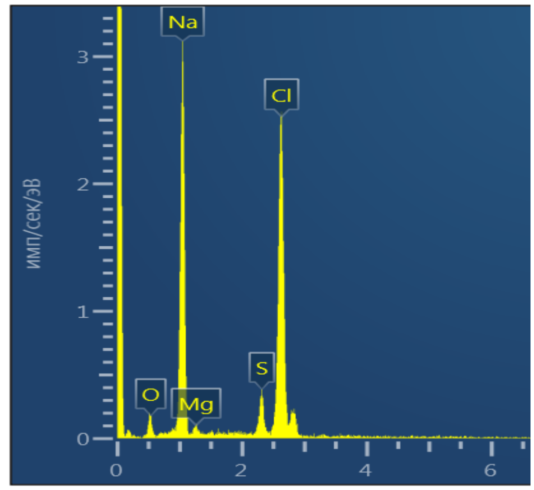


Fig.7 Storage of mineral salts of *Azolla caroliniana* biomass grown for 14 days, mg / g





The growth of *Azolla caroliniana*, *Lemna minor*, *Pistia stratiotes, Eichhornia srassipes* in water containing chromium (Cr^{6+}) has been comparatively studied. The chemical composition of the tannery effluents was determined at the beginning and after the physicochemical treatment. An adapted culture of *Azolla carolina*, resistant to 30% chromium, was obtained based on a high chromium content (handicraft water and plant effluents) and its viability was determined ((mg/l) 0,5→0,87%, 1,0→0,68%, 1,5→0,59%, 2,0→0,50%, 2,5→0,46%, 3,0→039%). Azolla carolina has been found to reduce the chromium content (from 4.87 mg/l chromium to 2.34 mg/l) in wastewater containing chromium at various concentrations. For the first time, the ability of sorption of chromium on average 0.56-1.09 mg/g relative to the dry mass of Azolla has been shown. Growth of Azolla, an accumulation of sodium was found 27.92 mg/g on the 7th day, 36.72 mg/g on the 10th day, chlorine 1.67 mg/g on the 7th day and 47.69 mg/g on 10th day.

References

Abdinazarov H. H., Kuzmetov A. R., Khaydarov S. M., Nomonov J. N. 2018. Qualitative and quantitative development of zooplankton organisms in Fergana valley water reservoir. JNAS.7-4/44-47.

Abdinazarov X. X., Madumarov M. J., Haydarov S. M. 2019. Zooplankton of Sarikamish Lake (Uzbekistan). Open Access Library Journal. Vol.6, e.5288, pp.1-8. doi:10.4236/oalib.1105288.

Arora, A., S. Saxena, and D. K. Sharma. 2006. Tolerance and phytoaccumulation of chromium by three Azolla species. World Journal of Microbiology & Biotechnology 22: 97–100.

Azimov Sh. Sh., Khujamshukurov N. A., Turabdjanov S. M., Kuchkarova D. Kh., Nigmatullaeva M. G. Resistance of macrophytes to chromium and purification of chromium from wastewater using *Azolla caroliniana*. Universum. 2022. 1(94). URL: https://7universum.com/ru/tech/archive/item/12980.

Brooks, R. R., and B. H. Robinson. 1998. Aquatic phytoremediation by accumulator plants. In Plants that hyperaccumulate heavy metals: Their role in phytoremediation, microbiology, archaeology, mineral exploration and phytomining, ed. Brook, R.R, 203–226. Wallingford, UK: CABI International.

Chang, J. S., I. H. Yoon, and K.-W. Kim. 2009. Heavy metal and arsenic accumulating fern species as potential ecological indicators in As-contaminated abandoned mines. Ecological Indicators 9: 1275–1279.

Cheng, S. 2003. Heavy metals in plants and phytoremediation. Environmental Science and

Pollution Research 10: 335–340.

Dhir, B., P. Sharmila, and P. P. Saradhi. 2009a. Potential of aquatic macrophytes for removing contaminants from the environment. CriticalReviewsinEnvironmentalScienceandTechnology 39: 754–781.

Dhote, S., and S. Dixit. 2009. Water quality improvement through macrophytes- a review. Environmental Monitoring and Assessment 152: 149–153.

Prasad, M. N. V., and H. Freitas. 2003. Metal hyperaccumulation in plants—Biodiversity prospecting for phytoremediation technology. Electronic Journal of Biotechnology 6: 285–321.

Khujamshukurov N. A. 2011. Alternative protein products. J. XXI technology.4(5):14-15.

Khujamshukurov N. A., Nurmuxamedova V. Z. 2016. Production feed: modern trend and development aspect. Scientific overview. J. Zoo veterinary.№8 (105):34-37.

Lokeshwari, H., and G. T. Chandrappa. 2007. Effects of heavy metal contamination from anthropogenic sources on Dasarahalli tank, India. Lakes and Reservoirs: Research and Management 12: 121–128.

Marques, A. P. G. C., A. O. S. S. Rangel, and P. M. L. Castro. 2009. Remediation of heavy metal contaminated soils: Phytoremediation as a potentially promising clean-up technology. Critical Reviews in Environmental Science and Technology 39: 622–654.

Mirzaeva D. A., Khujamshukurov N. A., Abdullaev X. O., Gazieva Sh. Q., Iskhakova Sh. X., Kuchkarova D. Kh. Nutritional Value of *Lemnaceae* Macrophytes. Int.J.Curr.Microbiol. App.Sci. 2020. 9(4):3233-3242.

Mirzaeva D. A., Khujamshukurov N. A., Maksumkhodzhaeva K. S., Abdullaev X. O., Gazieva Sh. Q., Iskhakova Sh. X., Kuchkarova D. Kh. Dependence of the Feed Environment on Protein Synthesis of Feed Insects. Int. J. Curr. Microbiol. App. Sci (2020) 9(04): 3225-3232.

Rai, L. C., J. P. Gaur, and H. D. Kumar. 1981. Phycology and heavy metal pollution. Biological Reviews of the Cambridge Philosophical Society 56: 99–151.

Rai, P. K., and B. D. Tripathi. 2009. Comparative assessment of *Azolla pinnata* and *Vallisneria spiralis* in Hg removal from G.B. Pant Sagar of Singrauli Industrial region, India. Environmental Monitoring and Assessment 148: 75–84.

Srivastava, J., A. Gupta, and H. Chandra. 2008. Managing water quality with aquatic macrophytes. Reviews in Environmental Science and Biotechnology 7: 255–266.

Suresh, B., and G. A. Ravishankar. 2004. Phytoremediation: A novel and promising approach for environmental clean-up. Critical Reviews in Biotechnology 24: 97–124.

Shakirov Z. S., Khalilov I. M., Khujamshukurov N. A. Stress factors'effects on the induction of lipid synthesis of microalgae. J ApplBiol Biotech 2021; 9(06):149-153.

Umali, L. J., J. R. Duncan, and J. E. Burgess. 2006. Performance of dead *Azolla filiculoides* biomass in biosorption of Au from waste water. BiotechnologyLetters 28: 45–49.

Yadav, S. K., A. A. Juwarkar, G. P. Kumar, P. R. Thawale, S. K. Singh, and T. Chakrabarti. 2009. Bioaccumulation and phytotranslocation of arsenic, chromium and zinc by *Jatropha curcas* L.: Impact of dairy sludge and biofertilizer. Bioresource Technology 100: 4616–4622.

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