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A.Mamadaliyev, X.Kushiyev, Z.Abdullayeva
Sirdaryo viloyati sharoitida og‘ir metallardan *Cannabis Sativa L.*o‘simliklarining himoya qilishda fenolli tizimi 358
A.Turdaliyev, K.Asqarov, M.Aktamov
Sug‘oriladigan tuproqlarning biogeokimyoviy muammolari 363

ILMIY AXBOROT

F.Madraximova
Yoshlar ma’naviyatini shakllantirishda hamkorlik texnologiyalari 369
M.Nasirov
Badiiy matnning assotsiativ maydon tahlili........ 372
B.Muxtoraliyev
Anvar Obidjon ijodi adabiyotshunoslik ko‘zgusida 375
X.Mamatismoilova
Tarixiy etnolisoniy jarayonlar va o‘zbek xalqining milliy tili 379
K.Topvoldiyev
Lingvokulturologiyada “sharq” konseptining masalalari 384
Z.Akbarova, D.Rustamova
Boshlang‘ich sinf o‘quvchilari nutqida leksik sinonimlarni faollashtirish bosqichlari 388
Song Ho-Lim
Chig‘atoy turkiyning adabiy-uslubiy xususiyatlari........ 391
O.Uzaqova
Ingliz va o‘zbek tillarida kompyuter terminografiyasining lingvistik xususiyatlari........ 396
F.Anvarova
Ilk o‘rganuvchilarda ingliz tili o‘qitishning pedagogik usullari 400
Sh.Iskandarova, S.Sotvoldiyeva
Mavhum otlar va ularning o‘zbek tilshunosligidagi tadqiqi xususida 404
M.Yusupova
Evfemizmlar tasniflarining tahlili 407
F.Nurdinova
Tarjimada so‘z tanlash mahorati xususida........ 409
Sh.Sherg‘oziyev
«Boburnoma» matnidagi shaxslar tasvirida saj’i matavoziyning o‘rni va ularning inglizcha tarjimalarda aks etishi........ 413
Z.Pazilova
O‘zbek va nemis tillarida dafn marosimi bilan bog‘liq leksik birliklar tahliliga doir 416
Z.Axmedova
Lingvokulturologiya nazaridagi rimlar........ 420
Sh.Dushatova
Tabu so‘zlar o‘rganilishi va kelib chiqish tahlili........ 425

BIBLIOGRAFIYA 428

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SIRDARYO VILOYATI SHAROITIDA OG'IR METALLARDAN *CANNABIS SATIVA* L.O'SIMLIKLARINI HIMOYA QILISHDA FENOLLI TIZIMI

ФЕНОЛЬНАЯ СИСТЕМА В ЗАЩИТЕ РАСТЕНИЙ CANNABIS SATIVA L. ОТ ТЯЖЕЛЫХ МЕТАЛЛОВ В СЫРДАРЬИНСКОЙ ОБЛАСТИ

PHENOLIC SYSTEM IN THE PROTECTION OF PLANTS CANNABIS SATIVA L. FROM HEAVY METALS IN SYRDARYA REGION

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Annotasiya

Ushbu maqolada Sirdaryo viloyatida yetishtirilgan o'simlik (Cannabis sativa L) va tuproq na'munalarida og'ir metallar (Hg, Pb, Cr, Sn, Ni, Cu, Fe, Mn, Zn) miqdorini o'rganish natijalari ko'rib chiqildi. O'simliklarni himoya qilishning antioksidant tizimining (fenollar va flavonoidlar) javobi ham o'ziga xos bo'lib, antioksidant miqdorining oshishi va pasayishi ham kuzatiladi, bu o'simliklarning ifloslantiruvchi moddalar ta'siriga turli xil chidamliligi bilan bog'liqdir. Ba'zi hollarda og'ir metallar tarkibi, fenollar va flavonoidlar darajasi o'rtasida korrelyatsiya aniqlandi, bu o'simliklarning biokimyoviy stressininпg sababini ko'rsatadi.

Аннотация

В этой статье расмотриваются результаты исследования содержания тяжелых металлов (Hg, Pb, Cr, Sn, Ni, Cu, Fe, Mn, Zn) в растительных (CannabissativaL) и почвенных пробах, выращенных в условиях засоленных почв Сырдарьинской области. Ответная реакция антиоксидантной системы защиты растений (фенолы и флавоноиды) была специфичной, наблюдалось как повышение, так и снижение содержания антиоксидантов, что обусловлено различной устойчивостью растений на действие поллютантов. В ряде случаев обнаружены корреляции между содержанием тяжелых металлов и уровнем фенолов и флавоноидов, что указывает на причину биохимического стресса растений.

Abstract

This article discusses the results of a study of the content of heavy metals (Hg, Pb, Cr, Sn, Ni, Cu, Fe, Mn, Zn) in plant (CannabissativaL) and soil samples made in saline soils of Syrdarya region. The reaction of the antioxidant defense system of plants (phenols and flavonoids) was also specific, both an increase and a decrease in the antioxidant status were observed, which is due to the different resistance of plants to the action of pollutants. In some cases, correlations were found between the content of heavy metals and the level of phenols and flavonoids, which indicates the cause of the biochemical stress of plants.

Kalit so'zlar: *og'ir metallar, fenollar, flavonoidlar, antioksidantlar, tuproq va o'simliklardagi metall konsentratsiyasi.*

Ключевые слова: *тяжелые металлы, фенолы, флавоноиды, антиоксиданты, концентрации металлов в почве и растениях.*

Key words: *heavy metals, phenols, flavonoids, antioxidants, metal concentrations in soil and plants.*

INTRODUCTION

One of the important tasks of modern agroecology is the study of the patterns of circulation in the biosphere of chemical elements which regulate biological processes. Heavy metals (HMs) occupy a special place among such elements. Conventionally, they include chemical elements with an atomic mass of more than 50, which have the properties of metals or metalloids and are considered the most toxic. Metals such as tantalum, platinum and gold are physiologically inert. Be, Co, Ni, Cu, Zn, Sn, As, Se, Te, Pb, Cd, Hg, Rb, etc. are very toxic. Some of them are known as trace elements, the importance of which in the metabolic process has been scientifically proven, they are used in agriculture and medicine. Most often, the term heavy metals is considered not from a chemical, but from a medical and environmental point of view, since their biological activity and toxicity are taken into account. The degree of mobility of heavy metals in the soil and their penetration into plants are very variable and depend on soil and climatic conditions, the type and age of plants, and the intensity of anthropogenic impact on the environment. Therefore, the content of HMs in plants on uncontaminated soils varies widely [1–6]. Under conditions of chemical stress caused by an excess of elements, plants have developed mechanisms in the course of evolution that lead to resistance and imbalance in the chemical balance in the environment. The main pathway for metals to enter plants is absorption by roots. Therefore, the soil environment is the main source of elements for plants, the root system of which can absorb heavy metals actively (metabolically) and passively (non-metabolically). In most cases, the absorption rate of elements positively correlates with the content of their available forms [6–8]. Heavy metals can also enter plants through the non-root route from air currents. In practice, spraying of plants with solutions of trace elements is widely used: iron, copper, manganese, molybdenum and others. The input of elements into plants through the leaves, or foliar absorption, occurs through non-metabolic penetration through the cuticle. The metals absorbed by the leaves can be transferred to other plant tissues, in particular, to the roots, in which they can remain in the form of a reserve for a long time. Chelating ligands play the most important role in the transport of cations in plants. HMs migration routes can be different, but, as a rule, they always enter the soil, where they are absorbed by plants. It is widely known that some HMs is necessary for the normal life of plants. However, their accumulation above certain concentrations inhibits the growth and development of plants, causes chlorosis and leaf necrosis. The danger of HMs for plants is exacerbated by the presence of a cumulative effect [9]. HM toxicity is based on their ability to bind to functional groups of biomolecules (–COOH, –OH, –NH2, –SH, phosphoric acid residues in ATP), which leads to disruption of the structure and functioning of proteins, including enzymes, carbohydrates, and other molecules. In addition, HMs are able to replace essential elements from metal-containing complexes [10]. Plants need antioxidants to protect against oxidative stress. Antioxidants include plant phenols, as well as flavonoids belonging to the class of phenolic compounds. The latter are flavone hydroxy derivatives with different numbers of –OH groups. Phenolic compounds are found in plants in the form of glycosides or in the free states: they are found in almost all plants in amounts from 0.1% to 7%. Phenols and flavonoids are involved in many physiological processes, including photosynthesis, respiration, growth, and defense reactions of plants. The biological activity of plant phenols and flavonoids is of interest for studying the effect of anthropogenic environmental factors on the level of flavonoids in plants, including foodstuffs. In [11], the content of biologically active compounds, in particular flavonoids, in the plant *Cannabis sativa L* was studied. In the study [2,6], the role of accumulation of flavonoids as an adaptation to the salinity of the environment was established. Previously, researchers have studied the content of flavonoids in different phases of vegetation underground and surface part of *Cannabis sativa L.* in the conditions of the Syrdarya region, however, the content of pollutants in plants was not studied, which does not suggest the reason for the change in the status of antioxidants. The literature describes conflicting results on the reaction of antioxidant defense systems [12], including phenols and flavonoids [13, 14], in response to HMs accumulation. Apparently, the response of plants depends on the growing conditions, the active pollutant and its concentration, plant species, and other factors. Nevertheless, in the available literature, we did not find any experimental data on a broad study of the effect of accumulation of HMs in plants of various species from the urban environment on the content of plant phenols and flavonoids [14–17].

The aim of this work is to study the effect of HMs (Hg, Pb, Cr, Sn, Ni, Cu, Fe, Mn, Zn) in *Cannabis sativa L* herbaceous plants in Syrdarya region for the content of plant flavonoids.

MATERIALS AND METHODS

For sample preparation, all samples were dried to constant weight at a temperature of 105 ^{0}C for three hours, after which they were ground to a homogeneous powder and sifted through a sieve with a diameter of 1 mm. Soil samples from the Syrdarya region are interesting in that they represented different soil conditions, and also have a high salt content, which is usually available for many countries. For the preparation of soil samples, the extraction method was chosen because it is the most commonly used method for analysis. A mixture of hydrochloric and nitric acid was used for extraction, and as expected, each sample left an insoluble precipitate after decomposition. Prior to analysis, soil samples were prepared by microwave digestion in a closed vessel using a microwave digestion system (MILESTONE Ethos Easy, Italy).All samples were prepared by microwave digestion using a microwave digestion system (MILESTONE Ethos Easy, Italy). 200 mg of sample was added to each vial, followed by 6 ml of concentrated nitric acid (HNO_3) and 2 ml of hydrogen peroxide (H_2O_2). After that, the vessels were closed and the device was placed at 180 ^{0}C for 20 minutes for heating and dissolution. After decomposition was complete, the samples were transferred to 25 ml volumetric flasks and diluted to 25 ml with deionized water. We will check this solution with the Avio 200 instrument ICP - OES (Optical Emission Spectroscopy with Inductively Coupled Plasma).

Results of heavy metals in the element-soil-plant system

RESULTS AND DISCUSSION

Heavy metals were determined in soil samples, plants during the growing season in 2021 and the change in elemental composition was studied. As a result of optical emission spectroscopy with inductively coupled plasma, the content was determined and the change in the elemental composition in the element-soil-plant system was studied.

Table 1.

The content of macro and microelements in soil samples and plants							
№	Element/wavelength (nm)	Content mg/l					
		The soil		underground part		Overground part	
		The control	Sample	The control	Sample	The control	Sample
1	Fe 238.204	101.7	71.18	2.137	3.264	0	0
2	Cr 267.716	2.55	2.259	0.008	0.011	0	0
3	Mn 257.610	74.329	88.096	0.009	0.106	0	0.001
4	Ni 231.604	2.554	3.151	0	0.004	0	0
5	Cu 327.393	17.218	27.149	0.02	0.037	0	0
6	Zn 206.200	76.213	89.92	0.011	0.104	0	0.012
7	Pb 220.353	0.592	1.973	0	0.002	0	0
8	Hg 253.652	0	0	0	0.002	0	0
9	Sn 189.927	2.951	2.827	0.009	0.025	0	0.001

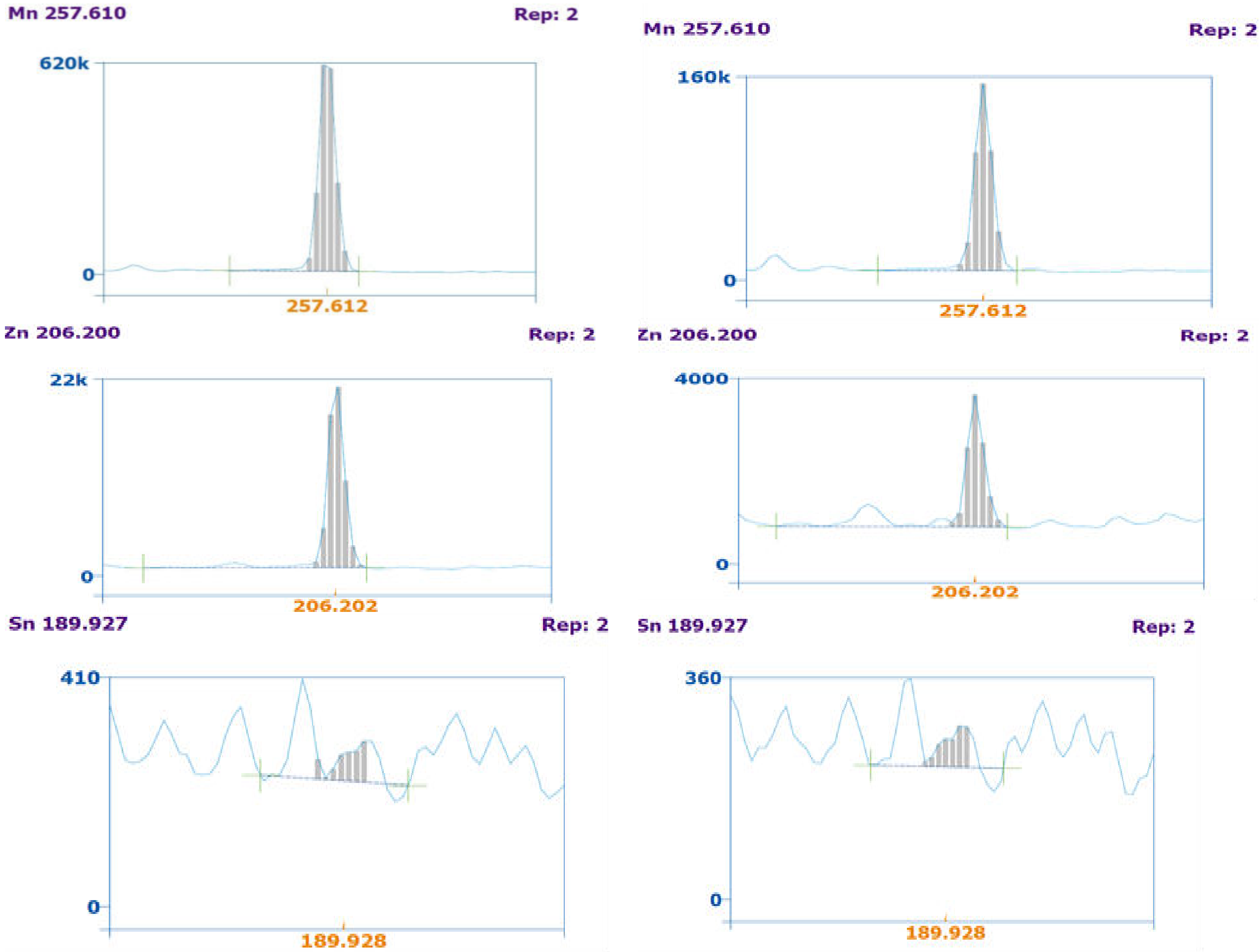

Fig.1. Spectrogram of Mo, Zn and Sn soils and aboveground parts of *Cannabis sativa L*

Table 2

The results of the chromatographic analysis of *Cannabis sativa L*

№	Name	Компонент	Hold time	Peak area	Peak Height	Conc. underground fraction mg/l	Con-tion aerial part mg/l
1	Standard	Quercetin	9.49	594518	14543	1,000	1,000
2	Control.Plants	Quercetin	9.47	67952	1759	0,02	0,1
3	*CannabissativaL.*	Quercetin	9.56	71152	1969	0,05	0,3

From the above, it is possible to lead in some positive correlation of the content of metals with the level of phenolic compounds in plant cells: Mn, Zn and Sn in the underground surface of a part of the control plant were 0.09, 0.011 and 0.09 mg/l; in the aerial surface parts of *Cannabis sativa L*. 0.0 mg/l. Underground parts of the plant *Cannabis sativa L*. non-control Mn, Zn and Sn was 0.106, 0.104 and 0.025 mg/l; in above ground parts 0.01, 0.012 and 0.001 mg/l. The result obtained can be associated with both the life-stimulating doses of HMs and their stressful effect and the synthesis of phenolic antioxidants to block the processes of peroxidation and chelation of metal ions. The second version is probably more preferable in the case of a high level of accumulation, since flavonoids are related compounds in relation to phenolic antioxidants, the mechanisms for the appearance of this correlation are probably similar to those described above for phenols. Thus, the correlation analysis showed that biochemical stress caused by the accumulation of HM in plant cells provokes them to synthesize phenols and flavonoids to increase the antioxidant status: the higher the concentration of HM (Mn, Zn and Sn), the higher the content of phenols and flavonoids.

CONCLUSION

Based on the results obtained, the following conclusions can be drawn. The change in HM on the soil grown *Cannabis sativa L* decreased in the series Hg>Pb>Cr>Sn>Ni>Cu>Fe>Mn>Zn. Exceeding the content of Zn, Hg in soil samples failed, their content is at the level of 0.0 mg/l. HM decreased on the underground part of the plant in the series Hg>Pb>Ni>Cr>Sn>Cu>Zn>Mn>Fe and the aboveground part of *Cannabis sativa L.* decreased in the series Fe>Cr>Ni>Cu>Pb>Hg>Mn>Sn>Zn. Fe, Cr, Ni, Cu, Pb, Hg were not determined in samples of the aboveground parts of plants; their content was at the level of 0.0 mg/l. The response of the flavonoid plant protection systems to the action of HMs was as specific as directed: the synthesis of flavonoids. The obtained result is explained by different stability and behavior of plants under stress conditions. In a number of cases, significant positive correlations were found between the content of Mn, Sn, and Zn and the level of flavonoids in plant cells, indicating the cause of biochemical stress in plants.

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