Investigating the urban land pollution level according to the bioindicator properties of plants

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Abstract. In this article, the bioindicator properties of *Taraxacum officinale*, a common plant in urban areas, are studied. The existence of a correlation between the environment and the content of heavy metals in plants determines the use of plants as indicators of natural and anthropogenic landscapes. The existence of a relationship between the amount of heavy metals in the environment and plants determines their use as indicators of pollution of natural and anthropogenic landscapes. Plant organisms are recognized as adequate bioindicators of environmental quality. It is *T. officinale* that is suitable for identification and has adequate response to changes in environmental conditions. As a bioindicator, plants in urban and industrial areas are used for biomonitoring. In our scientific research, the use of *T. officinale* species as a bioindicator of atmospheric and soil pollution was investigated for the first time in the conditions of Uzbekistan. In order to determine the accumulation of some heavy metals in the observation areas, the correlation of climate, soil and plant indicators was determined using mathematical analysis methods.

1 Introduction

Areas with production centers in different countries of the world, automobile transport, emissions from factories and factories, nuclear and hydroelectric power plants, mechanical engineering, metallurgy, production of construction materials, and the development of urban planning have determined the impact on plant species. Also, global changes in the atmosphere as a result of large-scale transportation of daily goods have a lasting effect on plant species. In recent decades, the city's atmospheric air has been polluted by exhaust gases and dust from transport vehicles, as well as industrial waste. This leads to local and global climate change, deterioration of human life, life of other organisms and deterioration of public health [1-4].

Toxic gases and heavy metals released into the atmosphere accumulate in the environment and plants. The formation and accumulation of biologically active substances in medicinal plants is a dynamic process that changes during the ontogeny of plants and depends on many environmental factors, including anthropogenic factors. The existence of a correlation between the environment and the content of heavy metals in plants determines the use of plants as indicators of natural and anthropogenic landscapes. The existence of a relationship between the amount of heavy metals in the environment and plants determines their use as indicators of pollution of natural and anthropogenic landscapes [2-5].

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Bioindicators are reliable indicators of environmental pollution and are one of the cheapest methods in the process of environmental monitoring. The use of urban plants as a bioindicator for biomonitoring is very relevant. Plant organisms are recognized as adequate bioindicators of environmental quality. It is *T. officinale* that is suitable for indification that is resistant to atmospheric pollution and has adequate response to changes in environmental conditions [6-8].

As a bioindicator, plants in urban and industrial areas are used for biomonitoring. In our scientific research, the use of *T. officinale* species as a bioindicator of atmospheric and soil pollution was investigated for the first time in the conditions of Uzbekistan. In order to determine the accumulation of some heavy metals in the observation areas, the correlation of climate, soil and plant indicators was determined using mathematical analysis methods. In it, the accumulation of heavy metals in the 0-30 cm depth of the soil, in plant organs and their migration was carried out, taking into account climate and anthropogenic pressure. Among the most dangerous heavy metals in plants, toxic elements Pb and Cd have been found to be more abundant than other elements.

2 Materials and methods

We know that air pollution has a negative effect on plants. In cities, various harmful chemicals released from industrial enterprises and motor vehicles accumulate in plants and soil through atmospheric air.

For this purpose, samples of *T. officinale* were taken in Uzbekistan, especially from the roadsides of Tashkent city, around the Uzbekkimmash JSC (Chirchik city), and Gazalkent city, and T officinale species planted from the Tashkent Botanical Garden were also taken from a clean area for comparison. Because of this, the climate, weather, solar radiation, temperature, air pollution levels of the experimented area with these urban areas were also taken into account. Actual mathematical statistical processing was performed using generally accepted methods [9, 10]. An appropriate statistical data processing program (Microsoft Excel) was used for data calculation and analysis.

3 Results and discussion

Bioindicators of plants taken from different areas, i.e., the surroundings of the Uzkimmash JSC of Chirchik city, the large ring road and roadsides of Yunusabad district, the surroundings of the gas station of Yunusabad district, and the surroundings of the Chirchik River in Gazalkent city, the accumulation of some heavy metals in the soil, as well as the climate indicators of the areas were taken into account to calculate internal correlations. In the surroundings of Uzkimmash JSC of Chirchik city (Pb - $r=0.96$; $p<0.05$, Cd - $r=0.94$; $p<0.05$), in the large ring road and roadsides of Yunusabad district (Pb - $r=0.99$; $p<0.01$, Cd - $r=0.98$; $p<0.01$), and around the Chirchik River in Gazalkent city (Cd - $r=0.97$; $p<0.01$), pollution was considered strong and it was found to be related to soil (Tables 1-3).

Table 1. Accumulation of hazardous chemical elements in root, leaf, and flower of *T. officinale*.

Area	Body of plant	Pb, µg/g	Cd, µg/g
Tashkent city, along the ring road	Leaf	8.485	0.382
	Flower	3.858	0.192
	Root	6.304	0.176
50 m	Leaf	3.312	0.196

	Flower	4.368	0.159
	Root	1.997	0.107
100 m	Leaf	5.421	0.195
	Flower	2.869	0.112
	Root	3.177	0.154
200 m	Leaf	1.233	0.074
	Flower	2.806	0.082
	Root	0.333	0.031
350 m	Leaf	5.808	0.198
	Flower	2.004	0.245
	Root	2.912	0.079

Table 2. Bioindicators of *T. officinale* and *T. kok-saghyz* plants, accumulation of some heavy metals in soil, and climate indicators.

Indicators		***T. officinale***					***T. kok-saghyz***
		Chirchik city, the surroundings of the Uzkimmash JSC	**Large ring road of Yunusabad district**	**Yunusabad district, around the gas station**	**Surroundings of the Chirchik River in the city of Gazalkent**	**Botanical garden**	**Botanical garden**
		V_1	**V_2**	**V_3**	**V_4**	**V_5**	
Pb, µg/g		6.778	0.175	5.534	5.084	0.04	0.06
Cd, µg/g		0.223	7.986	0.312	0.618	0.294	0.156
Soil	Cd, µg/g	0.131	0.142	0.142	70.343	0.815	0.815
	Pb, µg/g	1.091	12.607	12.607	6.815	73.602	73.602
Climate factors	Average annual temperature, $+^0C$	14.3	14.7	14.7	14.1	14.7	14.7
	Annual sum of precipitation, mm	480	440	440	520	440	440
	Average annual humidity, %	59	56	56	63	56	56

Table 3. Correlation (r) of soil contamination with heavy metals.

	V_1	**V_2**	**V_3**	**V_4**
V_1	1			
V_2	0.94	1		
V_3	0.94	0.99	1	

V_4	0.96	0.98	0.98	1
V_5	0.96	0.98	0.98	0.97

Correlation (r) of Pb content in plant bodies with observation areas: in the leaf of a plant along the ring roady - r=0.90; p<0.05 and at the root - r=0.94; p<0.05, on the leaf of a plant located 50 meters from the ring road - r=0.97; p<0.01, and in the flower of the plant located 100 meters from the ring road - r=0.99; p<0.01 was found strong dependency on soil contamination. In the flower and leaf of the plant, it can be seen that the pollution through atmospheric air is strong (Tables 4-6).

Table 4. Accumulation of some heavy metals in the body of *T. officinale* plant.

	Body of plant	**Heavy metals, µg/g**	
		Pb	**Cd**
Along the ring road	Leaf	8.485	0.382
	Flower	3.858	0.192
	Root	6.304	0.176
50 m	Leaf	3.312	0.196
	Flower	4.368	0.159
	Root	1.997	0.107
100 m	Leaf	5.421	0.195
	Flower	2.869	0.112
	Root	3.177	0.154
200 m	Leaf	1.233	0.074
	Flower	2.806	0.082
	Root	0.333	0.031
350 m	Leaf	5.808	0.198
	Flower	2.004	0.245
	Root	2.912	0.079

Table 5. Pb in *T. officinale* plant bodies growing on the ring road in Yunusabad district in relation to the distance, µg/g.

	Ring road	50 m	100 m	200 m	350 m
Leaf	8.485	3.312	5.421	1.233	5.808
Flower	3.858	4.368	2.869	2.806	2.004
Root	6.304	1.997	3.177	0.333	2.912

Table 6. Correlation (r) of monitoring zones with heavy metals in plant bodies.

	Ring road	50 m	100 m	200 m
Ring road	1			
50 m	-0.47	1		

100 m	0.90	-0.04	1	
200 m	-0.65	0.97	-0.26	1
350 m	0.94	-0.16	0.99	-0.37

Accumulation of heavy metals in *T. officinale* species and in soil and correlation (r) with climate indicators was determined below. In the surroundings of the Uzkimmash JSC and in the ring road and roadsides of the Yunusabad district (Pb - r=0.99; p<0.01, Cd - r=0.98; p<0.01) and around the Chirchik river in the city of Gazalkent (Cd - r= 0.95; p<0.01) it was determined that accumulated heavy metals are associated with atmospheric air pollution (Tables 7-10).

Table 7. Pb and Cd content of *T. officinale* growing in the observation area and climate indicators.

Indicators		**Areas of investigation**			
		Chirchik city, the surroundings of the Uzkimmash JSC	**Large ring road of Yunusabad district**	**Surroundings of the Chirchik River in the city of Gazalkent**	**Botanical garden**
		V_1	**V_2**	**V_3**	**V_4**
Pb, µg/g		6.778	0.175	5.084	0.04
Cd, µg/g		0.223	7.986	0.618	0.294
Soil	Cd, µg/g	131.84	0.142	70.343	0.815
	Pb, µg/g	1091.75	12.607	6.815	73.602
Climate factors	Average annual temperature, $+^0$C	14.3	14.7	14.1	14.7
	Annual sum of precipitation, mm	480	440	520	440
	Average annual humidity, %	59	56	63	56

Table 8. Correlation (r) of the content of Pb and Cd in *T. officinale* plant growing in the observation area and climate indicators with distance.

	V_1	**V_2**	**V_3**	**V_4**
V_1	1			
V_2	0.94	1		
V_3	0.96	0.98	1	
V_4	0.96	0.98	0.97	1

Table 9. Pb and Cd content of *T. officinale* growing in the observation area and climate indicators.

Indicators	**Areas of investigation**			
	Chirchik	**Gazalkent**	**Yunusabad district, around the gas station**	**Botanical garden**

		V_1	V_2	V_3	V_4
Pb, µg/g		6.778	5.084	5.534	0.04
Cd, µg/g		0.223	0.618	0.312	0.294
Soil	Cd, µg/g	0.131	70.343	0.142	0.815
	Pb, µg/g	1.091	6.815	12.607	73.602
Climate factors	Average annual temperature, $+^0$C	14.3	14.1	14.7	14.7
	Annual sum of precipitation, mm	480	520	440	440
	Average annual humidity, %	59	63	56	56

Table 10. Correlation (r) of the content of Pb and Cd in *T. officinale* plant growing in the observation area and climate indicators with distance.

	V_1	V_2	V_3	V_4
V_1	1			
V_2	0.98	1		
V_3	0.98	0.95	1	
V_4	0.99	0.95	0.99	1

The data obtained at the end of the research showed that *T. officinale* can be used as a bioindicator in the detection of environmental pollution. Environmental pollution was studied on the *T. officinale* plant along the ring road of Tashkent city and in the areas 50 m, 100 m, 200 m, and 350 m from the road. As a result, it was found that the leaves and flowers of the plant are indicators of surface pollution, and the root parts are indicators of soil pollution with the most dangerous elements, toxic and weakly toxic elements. When the migration of heavy metals is analyzed mathematically, taking into account plant, soil and climate parameters, heavy accumulation of heavy metals in the roots of plants is a strong pollution of the soil. In addition, it was found that pollution in flowers and leaves is related to atmospheric air pollution.

4 Conclusions

When analyzing and comparing the composition of plants and soil taken from different areas, i.e. the surroundings of the Uzkimmash JSC in Chirchik city, on the ring road and roadsides in Yunusabad district, around the gas station in Yunusabad district, and around the Chirchik river in Gazalkent city, the surroundings of the Uzkimmash JSC in Chirchik city are different in terms of atmospheric air and soil compared to other areas and showed a high level of pollution. The presence of large amounts of heavy metals in the roots of plants in the samples taken on the ring roads in Yunusabad district of Tashkent city in comparison to the clean landscape showed that the level of soil pollution in this area is relatively high.

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