

ECOTOXICOLOGICAL ASSESSMENT OF HOUSEHOLD PLOTS SOILS OF KRASNOYARSK BY REACTIONS OF TEST OBJECTS

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Abstract

The article deals with pollution research of household plots soils located in the city boundaries of Krasnoyarsk by bio-testing technique. The bio-testing technique makes it possible to take into account the pollutants aggregate interaction. There has been done the eco-toxicological assessment of soils samples in six districts by two test objects reactions: Californian worm and infusoria. The bio-testing results showed that samples of soils in the five of the six researched districts of Krasnoyarsk are characterized as non-toxic or tolerably toxic within the whole duration of experiment and in one district the test-objects showed the weak toxic effect.

Key words: soils, bio-testing, toxicity, test object, sample, control

INTRODUCTION

One of the main components of biosphere is topsoil. It is the topsoil that predetermines many processes occurring in the biosphere. Soils perform the functions of biological absorber, destructor and neutralizer of various pollutions. If this link of biosphere is destructed, then the existing biosphere functioning will be irreversibly broken [1, 7].

Therefore, it is of utmost importance to study the top soil significance, it's up to date state and changes under the impact of anthropogenic activity.

The techno-genic impact on the environment in big industrial centers results in anthropogenic impact increase on the environment, public health deterioration and soils fertility decrease. In the period of snow-thawing all the hazardous admixtures get from snow into the soil which may result in its fertility decrease and pollution [2, 4].

At the bio-monitoring performance with the purpose of environment control the bio-indicators are often used. Bio-indicators (Greek bios – life and Latin indico –point out, identify) are organisms or organisms communities which presence, amount or development peculiarities serve as indicators of natural processes, conditions or anthropogenic changes of habitat. Many organisms a rather sensitive and selective as related to the various habitat factors (chemical composition of soils, water, atmosphere, climatic and weather conditions, presence of other organisms, etc.) and can exist only within certain, often narrow boundaries of these factors changes [5, 6, 9].

The bio-testing techniques make it possible to take into account the aggregate interaction of pollutants (synergism), their mutual neutralization (antagonism) and biological accumulation of substances which enables to more thoroughly assess the pollution degree. That's why the biological techniques have been introduced into practice of toxicological control which enabled to improve the methods of ecosystems state assessment [3-6].

The research objects are the soils samples from household plots located in the city boundaries of Krasnoyarsk. The purpose of the work was to assess the soils toxicity of household plots within city boundaries of Krasnoyarsk by survivability of the Californian worm (*Eisenia foetida*) and infusoria (*Paramecium caudatum*).

MATERIALS AND METHODS [8, 10]

The characteristics of test object: red Californian worm *Eisenia foetida*.

Experiments were made in 3- time replication. As the toxicity indicator the reserves survivability assessed by the number of species survived. As toxicity criterion there served significant difference by Student's t-test of the control and experimental samples.

At experiments results processing we used toxicity index: $T_i = ((T_{ik} - T_{io}) / T_{ik}) * 100\%$, where $T_i = 0-0,25$, tolerable toxicity; $T_i = 0,26-0,70$, moderate toxicity; $T_i > 0,71$, high toxicity.

The characteristics of test object infusoria *Paramecium caudatum*.

For sharp impact assessment on the test-object we used the method of individual lines of *Paramecium*. As the toxicity indicator the reserves the survivability, assessed by the number of survived lines of *Paramecium*. Dynamics of fission and death of infusorians in different environments is registered: control- environment of Lozin- Lozinsky and the solution of tested substance.

The significant difference by Student's t-test of the control and experimental indicators informs about the stress impact, i.e. toxicity.

At experiments results processing we used toxicity index: $T_i = ((T_{ik} - T_{io}) / T_{ik}) * 100\%$, where $T_i = 0-0,25$, tolerable toxicity; $T_i = 0,26-0,70$, moderate toxicity; $T_i > 0,71$, high toxicity.

The soils samples were taken at the household plots of Krasnoyarsk from A-horizon (0-30 cm) in May 2016 in 3- time replication, integrated sample (Figure 1).

Sampling on seasons is substantiated by the beginning of spring and autumn works on household plots and possible soils pollution by the toxic substances accumulated in thawed snow.

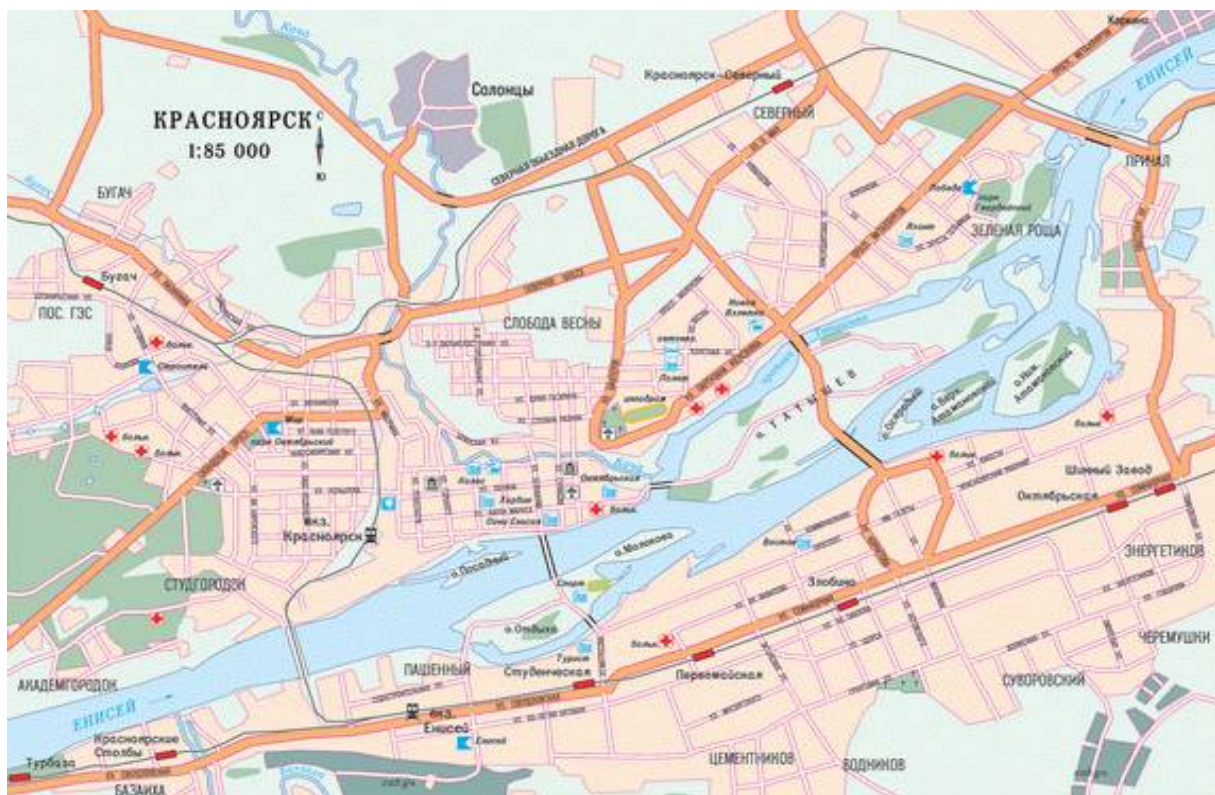


Figure 1. Schematic map of Krasnoyarsk

RESULTS ANALYSIS

Soils toxicity assessment of household plots of Krasnoyarsk by Californian worm survivability reaction.

In soil sample, station № 1a, taken on the territory of the Oktyabrsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The toxic effect didn't show itself after 7 days of experiment as well which enabled us to draw conclusion about non-toxicity of this sample: ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$ (Table1).

In sample, station № 1 b, taken on the territory of the Oktyabrsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw conclusion about the tolerable toxicity level of this sample ($p > 0,05$) ($T_i = 0,07$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,67 \pm 0$.

In soil sample, station № 1c, taken on the territory of the Oktyabrsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw conclusion about the tolerable toxicity level of this sample ($p > 0,05$) ($T_i = 0,13$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,33 \pm 0,41$.

Thus, the analyzed samples have been assessed as tolerably toxic and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 1 - Soils toxicity assessment of Krasnoyarsk done on the territory of the Oktyabrsky district (stations 1a, 1b, 1c), by red Californian worm survivability reaction *Eisenia foetida* (J_i , specimen)

Variant	Exposure, 24 hours	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o at $P < 0,05$
Control	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	
	7	$5,0 \pm 0,0$	
Station № 1a	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non- significant
	7	$5,0 \pm 0,0$	Non- significant
Station № 1b	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non- significant
	7	$4,67 \pm 0,41$	Non-significant
Station № 1c	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$4,33 \pm 0,41$	Non-significant

In soil sample, station № 2 a, taken on the territory of the Leninsky district after 7 days of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$ (Table 2).

In sample, station № 2 b, after 7 days of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

In soil sample, station № 2 c after first 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The toxic effect showed up after 7 days of experiment which enables us to draw conclusion about the moderate toxicity level of this sample: ($p < 0,05$) ($T_i = 0,27$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 3,67 \pm 0,82$.

Thus, the analyzed samples have been assessed as moderate toxic ($p < 0,05$) and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 2 - Soils toxicity assessment of Krasnoyarsk done on the territory of the Leninsky district (stations 2a, 2b, 2c) by red Californian worm survivability reaction *Eisenia foetida* (J_i , specimen)

Option	Exposure, 24 hours	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o at $P < 0,05$
Control	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	
	7	$5,0 \pm 0,0$	
Station № 2a	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non- significant
	7	$5,0 \pm 0,0$	Non-significant
Station № 2b	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$5,0 \pm 0,0$	Non-significant
Station № 2c	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$3,67 \pm 0,82$	Significant

In soil sample, station № 3 a, taken on the territory of the Sovetsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect (statistically not important) showed up only after 7 days of experiment which enables us to draw conclusion about the tolerable toxicity level of this sample: ($p < 0,05$) ($T_i = 0,13$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,33 \pm 0,41$. (Table3).

In soil sample, station № 3 b, taken on the territory of the Sovetsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$. The

toxic effect didn't show itself after 7 days of the experiment which enables to draw a conclusion about non- toxicity of this sample.

In the first soil sample, station № 3 c, taken on the territory of the Sovetsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$. This effect didn't show itself after 7 days of the experiment which enables us to draw a conclusion about non- toxicity, i.e. the tolerable toxicity level of this sample.

Thus, the analyzed samples have been assessed as tolerably toxic and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 3 - Soils toxicity assessment of Krasnoyarsk done on the territory of the Sovetsky district (stations 3a, 3b, 3c) by red Californian worm survivability reaction *Eisenia foetida* (J_i , specimen)

Option	Exposure, 24 hours	Experiment data $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	5,0±0,0	
	1	5,0±0,0	
	7	5,0±0,0	
Station № 3a	0	5,0±0,0	Non-significant Non-significant
	1	5,0±0,0	
	7	4,33±0,41	
Station № 3b	0	5,0±0,0	Non-significant Non-significant
	1	5,0±0,0	
	7	5,0±0,0	
Station № 3c	0	5,0±0,0	Non-significant Non-significant
	1	5,0±0,0	
	7	5,0±0,0	

In soil sample, station № 4 a, taken on the territory of the Central district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The toxic effect didn't show itself after 7 days of experiment as well which enables us to draw conclusion on non- toxicity of this sample: ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$ (Table 4).

In sample, station № 4 b, taken on the territory of the Central district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity level of this sample ($p > 0,05$) ($T_i = 0,07$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,33 \pm 0,41$.

In soil sample, station № 4 c, taken on the territory of the Central district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity level of this sample ($p > 0,05$) ($T_i = 0,13$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,67 \pm 0,41$.

Thus, the analyzed samples have been assessed as tolerably toxic and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 4 - Soils toxicity assessment of Krasnoyarsk done on the territory of the Central district (Stations 4a, 4b, 4c) by red Californian worm survivability reaction *Eisenia foetida* (J_i , specimen)

Option	Exposure, 24 hours	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	
	7	$5,0 \pm 0,0$	
Station № 4a	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$5,0 \pm 0,0$	Non-significant
Station № 4b	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$4,33 \pm 0,41$	Non-significant
Station № 4c	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	Non-significant
	7	$4,67 \pm 0,41$	Non-significant

In soil sample, station № 5 a, taken on the territory of the Zheleznodorozhny district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity level of this sample: ($p > 0,05$) ($T_i = 0,13$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,33 \pm 0,82$ (Table5).

In sample, station № 5 b, taken on the territory of the Zheleznodorozhny district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$), only weak inhibiting effect was noted ($T_i = 0,20$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,0 \pm 0,71$.

The weak toxic effect showed up and further on after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity level of this sample ($p > 0,05$) ($T_i = 0,20$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,0 \pm 0,71$.

In soil sample, station №5c, taken on the territory of the Zheleznodorozhny district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The weak toxic effect showed up after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity of this sample ($p > 0,05$) ($T_i = 0,13$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,67 \pm 0,41$.

Thus, the analyzed samples have been assessed as tolerably toxic and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 5 - Soils toxicity assessment of Krasnoyarsk located on the territory of the Zheleznodorozhny district (Stations 5a, 5b, 5c) by red Californian worm survivability reaction *Eisenia foetida* (J_i , specimen)

Option	Exposure, 24 hours	Experiment data $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	$5,0 \pm 0,0$	
	1	$5,0 \pm 0,0$	
	7	$5,0 \pm 0,0$	
Station № 5a	0	$5,0 \pm 0,0$	Non-significant
	1	$5,0 \pm 0,0$	
	7	$4,33 \pm 0,82$	
Station № 5b	0	$5,0 \pm 0,0$	Non-significant
	1	$4,0 \pm 0,71$	
	7	$4,0 \pm 0,71$	
Station № 5c	0	$5,0 \pm 0,0$	Non-significant
	1	$5,0 \pm 0,0$	
	7	$4,67 \pm 0,41$	

In soil sample, station № 6a, taken on the territory of the Kirovsky district after 24 hours of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

The toxic effect showed up after 7 days of experiment which enables us to draw a conclusion on the tolerable toxicity level of this sample: ($p > 0,05$) ($T_i = 0,07$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 4,67 \pm 0,41$ (таблица 6).

In sample, station № 6b, taken on the territory of the Kirovsky district after 7 days of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

In soil sample, station № 6c, taken on the territory of the Kirovsky district after 7 days of experiment by Student's t-test there was not observed the significant decrease of Californian worm survivability in comparison with control ($p > 0,05$) ($T_i = 0,0$): $X_k \pm m_k = 5,0 \pm 0,0$; $X_o \pm m_o = 5,0 \pm 0,0$.

Thus, the analyzed samples have been assessed as tolerably toxic and non-toxic ($p > 0,05$) during all 7 days of experiment.

Table 6 - Soils toxicity assessment of Krasnoyarsk located on the territory of the Kirovsky district (stations 6a, 6b, 6c), by red Californian worm survivability reaction *Eisenia foetida* (J_i specimen.)

Option	Exposure, 24 hours	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	5,0±0,0	
	1	5,0±0,0	
	7	5,0±0,0	
Station № 6a	0	5,0±0,0	Non-significant Non-significant
	1	4,67±0,41	
	7	4,67±0,41	
Station № 6b	0	5,0±0,0	Non-significant Non-significant
	1	5,0±0,0	
	7	5,0±0,0	
Station № 6c	0	5,0±0,0	Non-significant Non-significant
	1	5,0±0,0	
	7	5,0±0,0	

Household plots soils toxicity assessment by survivability reaction of test object – infusoria (*Paramecium caudatum*)

In soil sample, station №1a, taken in the Oktyabrsky district (neighborhood Vetluzhanka) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,06$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 6,70 \pm 0,22$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 7).

The significant toxic effect didn't show up and after 60 min of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 6,0 \pm 0,22$, which shows the tolerable toxicity degree ($T_i = 0,15$) of soil sample.

In the second soil sample, station № 1b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,02$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,10 \pm 0,29$. The samples have been assessed as tolerably toxic (Table 7).

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 5,90 \pm 0,24$, which shows the tolerable toxicity degree of soil samples ($T_i = 0,05$).

In the third soil sample, station №1c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,06$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,60 \pm 0,23$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

Table 7 - Soils toxicity assessment of household plots of the Oktyabrsky district of Krasnoyarsk (stations 1a, 1b, 1c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i , specimen), May 2016.

Option	Exposure, min.	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	7,10± 0,33	
	5	7,10± 0,33	
	60	7,10± 0,33	
Station № 1a	0	6,70±0,22	Non- significant
	5	6,70±0,22	
	60	6,0±0,22	
Control	0	6,20± 0,21	
	5	6,20± 0,21	
	60	6,20± 0,21	
Station № 1b	0	6,10±0,29	Non- significant
	5	6,10±0,29	
	60	5,90±0,24	
Station № 1c	0	6,60±0,23	Non-significant
	5	6,60±0,23	
	60	6,40±0,28	

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 6,40 \pm 0,28$, which shows the soil sample toxicity as tolerable ($T_i = 0,03$).

In the soil sample, station № 2 a, taken in the Leninsky district (neighborhood Bazaikha) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,10$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,80 \pm 0,31$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 8).

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 6,10 \pm 0,19$ which shows the tolerable toxicity degree ($T_i = 0,02$) of soil sample.

In the second soil sample, station № 2 b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,03$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,40 \pm 0,36$. The samples have been assessed as tolerably toxic.

Table 8 - Soils toxicity assessment of household plots of the Leninsky district of Krasnoyarsk (stations 2 a, 2 b, 2 c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i , specimen), May 2016.

Option	Exposure, min.	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	6,20± 0,21	
	5	6,20± 0,21	
	60	6,20± 0,21	
Station № 6a	0	6,80±0,31	
	5	6,80±0,31	Non-significant
	60	6,10±0,19	Non-significant
Station № 6b	0	6,40±0,36	
	5	6,40±0,36	Non-significant
	60	6,20±0,31	Non-significant
Control	0	7,10± 0,33	
	5	7,10± 0,33	
	60	7,10± 0,33	
Station № 6c	0	6,50±0,18	
	5	6,50±0,18	Non-significant
	60	5,10±0,29	Significant

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 6,20 \pm 0,31$, which shows the soil sample toxicity degree as tolerable ($T_i = 0,0$).

In the third soil sample, station № 2 c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,08$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 6,50 \pm 0,18$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect showed up after 60 min. of experiment ($p < 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 5,10 \pm 0,29$, which shows the soil samples toxicity as moderate ($T_i = 0,28$).

In soil sample, station № 3 a, taken in the Sovetsky district (community Badalyk) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,12$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 6,20 \pm 0,26$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 9).

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 6,20 \pm 0,26$, which shows the soil sample toxicity degree as tolerable ($T_i = 0,12$).

In the second soil sample, station № 3 b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,07$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 6,60 \pm 0,23$.

The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

Table 9 - Soils toxicity assessment of household plots of the Sovetsky district of Krasnoyarsk (stations 3a, 3 b, 3 c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i , specimen), May 2016.

Option	Exposure, min.	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P < 0,05$
Control	0	$7,10 \pm 0,33$	
	5	$7,10 \pm 0,33$	
	60	$7,10 \pm 0,33$	
Station № 3a	0	$6,20 \pm 0,26$	
	5	$6,20 \pm 0,26$	Non-significant
	60	$6,20 \pm 0,26$	Non-significant
Station № 3b	0	$6,60 \pm 0,23$	
	5	$6,60 \pm 0,23$	Non-significant
	60	$5,40 \pm 0,27$	Non-significant
Station № 3c	0	$5,90 \pm 0,19$	
	5	$5,90 \pm 0,19$	Non-significant
	60	$5,80 \pm 0,19$	Non-significant

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 5,40 \pm 0,27$, but the observed inhibiting effect proves the tolerable degree of soil samples toxicity ($T_i = 0,24$).

In the third soil sample, station № 3c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,17$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 5,90 \pm 0,19$.

The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 5,80 \pm 0,19$, which proves that soil samples toxicity is on the tolerable level. ($T_i = 0,18$).

In soil sample, station № 4 a, taken in the Central district (neighborhood Pokrovka) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,10$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_5 \pm m_5 = 6,40 \pm 0,17$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 10).

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 6,30 \pm 0,16$ which proves the tolerable degree of soil sample toxicity ($T_i = 0,11$).

In the second soil sample station № 4 b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,08$): $X_{k\pm m_k}=7,10\pm 0,33$; $X_{5\pm m_5}=6,50\pm 0,18$.

The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect didn't show up and after 60 min. of experiment ($p>0,05$): $X_{k\pm m_k}=7,10\pm 0,33$; $X_{60\pm m_{60}}=6,20\pm 0,14$, but the observed inhibiting effect proves the tolerable degree of soil samples toxicity ($T_i=0,13$).

In the third soil sample, station № 4 c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,08$): $X_{k\pm m_k}=7,10\pm 0,33$; $X_{5\pm m_5}=6,50\pm 0,17$.

The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect didn't show up and after 60 min. of experiment ($p>0,05$): $X_{k\pm m_k}=7,10\pm 0,33$; $X_{60\pm m_{60}}=5,80\pm 0,14$, which proves that degree of soil sample toxicity is on the tolerable level ($T_i=0,18$).

Table 10 - Soils toxicity assessment of household plots of the Central district of Krasnoyarsk (stations 4 a, 4 b, 4 c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i specimen), May 2016.

Option	Exposure, min.	Experiment data, $J_i\pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o , at $P<0,05$
Control	0	$7,10\pm 0,33$	
	5	$7,10\pm 0,33$	
	60	$7,10\pm 0,33$	
Station №4a	0	$6,40\pm 0,17$	
	5	$6,40\pm 0,17$	Non-significant
	60	$6,30\pm 0,16$	Non-significant
Station №4b	0	$6,50\pm 0,18$	
	5	$6,50\pm 0,18$	Non-significant
	60	$6,20\pm 0,14$	Non-significant
Station №4c	0	$6,50\pm 0,17$	
	5	$6,50\pm 0,17$	Non-significant
	60	$5,80\pm 0,14$	Non-significant

In the soil sample, station № 5 a, taken in the Zheleznodorozhny district (Bogotolsky St.) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,10$): $X_{k\pm m_k}=7,10\pm 0,33$; $X_{5\pm m_5}=6,40\pm 0,17$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 11).

Table 11 - Soils toxicity assessment of household plots of the Zheleznodorozhny district of Krasnoyarsk (stations 5 a, 5 b, 5 c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i specimen), May 2016.

Option	Exposure, min.	Experiment data $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o at $P < 0,05$
Control	0	7,10±0,33	
	5	7,10±0,33	
	60	7,10±0,33	
Station № 5a	0	6,40±0,17	
	5	6,40±0,17	Non-significant
	60	5,50±0,32	Non-significant
Control	0	6,20±0,21	
	5	6,20±0,21	
	60	6,20±0,21	
Station № 5b	0	6,0±0,22	
	5	6,0±0,22	Non-significant
	60	5,90±0,25	Non-significant
Station № 5c	0	6,70±0,27	
	5	6,70±0,27	Non-significant
	60	6,10±0,11	Non-significant

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 7,10 \pm 0,33$; $X_{60} \pm m_{60} = 5,50 \pm 0,32$, which shows the soil sample toxicity degree as tolerable ($T_i = 0,22$).

In the second soil sample, station № 5 b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,03$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,0 \pm 0,22$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 11).

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 5,90 \pm 0,25$, which shows the soil sample toxicity degree as tolerable ($T_i = 0,05$).

In the third soil sample, № 5c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p > 0,05$) ($T_i = 0,08$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,70 \pm 0,27$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect didn't show up and after 60 min. of experiment ($p > 0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 6,10 \pm 0,11$, which shows the soil sample toxicity degree as tolerable ($T_i = 0,02$).

In soil sample, station № 6 a, taken in the Kirovsky district (community Suvorovsky) after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of

infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,0$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,20 \pm 0,14$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample (Table 12).

The significant toxic effect didn't show up and after 60 min. of experiment ($p>0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 5,70 \pm 0,16$, which shows the soil sample toxicity degree as tolerable ($T_i=0,08$).

In the second soil sample, station № 6 b after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,11$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,90 \pm 0,33$. The samples have been assessed as tolerably toxic.

The significant toxic effect didn't show up and after 60 min. of experiment ($p>0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 5,90 \pm 0,19$, which shows the soil sample toxicity degree as tolerable ($T_i=0,05$).

In the third soil sample, station № 6 c after 5 minutes experiment by Student's t-test there was not observed the significant decrease of survivability of infusoria *Paramecium caudatum* in comparison with the control ($p>0,05$) ($T_i=0,02$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_5 \pm m_5 = 6,10 \pm 0,25$. The samples have been assessed as tolerably toxic which enables us to draw conclusion on the non-toxicity of this sample.

The significant toxic effect didn't show up and after 60 min. of experiment ($p>0,05$): $X_k \pm m_k = 6,20 \pm 0,21$; $X_{60} \pm m_{60} = 6,0 \pm 0,21$, which shows the soil sample toxicity degree as tolerable ($T_i=0,03$) (Table 12).

Table 12 - Soils toxicity assessment of household plots of the Kirovsky district of Krasnoyarsk (stations 6 a, 6 b, 6 c) by the survivability reaction of infusoria *Paramecium caudatum* (J_i , specimen), May 2016.

Option	Exposure, min.	Experiment data, $J_i \pm m_i$ (specimen)	Differences significance by Student's t-test J_k/J_o at $P<0,05$
Control	0	$6,20 \pm 0,21$	
	5	$6,20 \pm 0,21$	
	60	$6,20 \pm 0,21$	
Station № 6a	0	$6,20 \pm 0,14$	Non-significant
	5	$6,20 \pm 0,14$	
	60	$5,70 \pm 0,16$	
Station № 6b	0	$6,90 \pm 0,33$	Non-significant
	5	$6,90 \pm 0,33$	
	60	$5,90 \pm 0,19$	
Station № 6c	0	$6,10 \pm 0,25$	Non-significant
	5	$6,10 \pm 0,25$	
	60	$6,0 \pm 0,21$	

Therefore, there have been assessed a number of household plots soil samples within Krasnoyarsk boundaries by the survivability reaction of infusoria *Paramecium caudatum* and Californian worm *Eisenia foetida*.

In the soils samples taken on the territory of Krasnoyarsk there has been mainly noted non-significant decrease of survivability of test-objects by Student's t-test $p > 0,05$, the soils are characterized as tolerably toxic during the whole time of experiment ($T_i = 0,0-0,24$).

The highest toxicity level is observed in samples taken in the Leninsky district $p < 0,05$ ($T_i = 0,27-0,28$).

Therefore, as a result of analysis of household plots soils samples of Krasnoyarsk, it is possible to allocate the toxic area, except for the samples taken in other areas, which were assessed by indications of both test objects as nontoxic and tolerably toxic.

CONCLUSIONS

1. The tested household plots soils samples of Krasnoyarsk by survivability reaction of protozoa and oligochaete are estimated as tolerably ($T_i = 0,06-0,25$) and moderately toxic ($T_i = 0,27$).
2. The most significant toxic effect is not end mainly in soils samples taken in the Leninsky district assessed on the level of tolerable and moderate toxicity.
3. The toxic effect by the survivability indicator of infusoria *Paramecium caudatum* and Californian worm *Eisenia foetida* showed up mainly on the level 10 % and more of species mortality.
4. There has been noted the cells survivability decrease of infusoria *Paramecium caudatum* in test samples after 60 minutes of experiment and of species of Californian worm *Eisenia foetida* after 30 days of experiment.

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