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Prerequisites of Ecological Safety of Animal Husbandry Products

ABSTRACT

This article presents the results about influence of motor transport on accumulation of heavy metals (HM) of lead, zinc, copper and cadmium in the soil and in fodder plants of pasturable grounds of the Khangalassky region. Results of our researches testify that the pasture of cattle in close proximity to a highway can be the prerequisite of impurity of animal husbandry products by heavy metals. As a result of analyses of samples of the soils selected in the Khangalassky region showed that concentration of Pb, Cd, Cu, Zn in a soil cover of pasturable grounds of the village of Tekhtyur and village Nemyugyu don't exceed the established sanitary and hygienic standards. It is revealed that the maintenance of Pb, Cd, Zn, Cu in fodder herbs of pastures of the village of Tekhtyur and village Nemyugyu depended on their concentration in the soil. Thus the level of cadmium and lead in plants isn't exceeded by maximum concentration limit, and concentration of zinc and copper in 5 m of a highway exceeded maximum concentration limit.

Keywords: heavy metals, fodder herbs, soil, highway, motor transport.

INTRODUCTION

Nowadays environmental pollution by chemical compounds, including heavy metals is one of the main problems. In nature plants are affected by many stressors of both a natural, and anthropogenic origin. Having got to the soil, heavy metals can then collect in plants and make negative impact on processes of a metabolism that as a result leads to reduction of a crop and pollution by toxicum of the subsequent links of a food chain. The main sources of pollution by heavy metals are: road and transport complex, industrial enterprises, unutilized industrial and household wastes [14, 15, 16].

The significant contribution to pollution of environment is made by motor transport. Intensive receipt in environment of heavy metals which are emitted with exhaust gases is connected with its operation. Combustion of ethylated fuel is accompanied by release of lead. At combustion of lubricant oils emitted is cadmium. A large number of this element is formed as a result of attrition of tires about asphalt concrete [9].

The problem of providing the population with ecologically safe agricultural production is the priority direction of development of economy of our republic. Within a problem the important place is allocated for questions of development of animal husbandry in densely

populated areas of the Republic of Sakha (Yakutia). However, in areas with anthropogenic load in ecosystem the solution is impossible without professional knowledge on migration and accumulation of heavy metals in the soil, sterns and livestock production.

Natural pasturable grounds in the Central Yakutia, namely in Khangalassky district are located along the highway of republican importance. Toxic connections from the fodder plants eaten by animals on a trophic chain passes into an organism of cattle, then into animal husbandry products (meat, milk) which are consumed by local population.

The aim to define the influence of motor transport on accumulation of heavy metals of lead, zinc, copper and cadmium in the soil and in fodder plants of pasturable grounds of the Khangalassky region.

MATERIAL AND METHODS

Researches were conducted in the Khangalassky region of the village of Tekhtyur and the village Nemyugyu (Oi village), in pasturable meadows of the emissions of the motor transport located in a zone of influence.

Tekhtyursky district is located (village of Tekhtyur) on the left coast of the Lena River, in upper courses of small rivers Bestyakh, Suon, Urekh, and small rivers of Kenkeme, from the center of the district of Pokrovsk on 47 km, distance from Yakutsk of 27 km. The spread of the republican highway passing through the territory of the village of Tekhtyur is 2.15 km, including with a hard coating of 2.15 km. Transport connection is all the year round.

Nemyugyunsky district (Oi village) it is located on the left coast of the Lena River and there is in 7 km from the center of the district of Pokrovsk, a distance from Yakutsk to Oi village is 67 km. The transport connection with Yakutsk and Pokrovsk is carried out all the year round on the republican importance highway "Umnas" with a hard coating. Total length the insight districts of roads makes 35 km, including with a hard coating of 7 km, from them is covered with asphalt of 3 km.

The selection and preparation of tests of the soil and fodder herbs carried out in accordance with GOST 28168-89, 26929-94 ("Soils Sampling", "Raw materials and foodstuff"). The Concentration of lead, cadmium, copper and zinc was determined by method of the nuclear and absorbing spectral analysis (AAS MGA-915) in the accredited laboratories of State Budgetary Institution Republic of Sakha (Yakutia) and State Budgetary Institution Republic of Sakha (Yakutia) "Yakut republican veterinary and test laboratory" (GOST 30178-96, GOST 28168-89), determined

the maintenance of a humus by Tyurin's (State standard specification 26213-84) method, pH in a water extract of the soil defined in accordance with GOST 26423-85 [3, 4, 5, 6, 7].

Fodder herbs collected during blossoming (July) in a dry sunny weather, according to the standard rules [4].

The concentration of Pb, Cd, Cu, Zn in samples of soils and herbs determined by a nuclear and absorbing method in a flame acetylene-air on the MGA spectrophotometer – 915. For extraction HM from soils we used acetate ammonium the buffer with Ph-4,8 at a ratio soil/solution – 1/10, extraction time 24 hours. Sample preparation of vegetable raw materials is carried out by method of a dry combustion with the subsequent extraction by the nitric acid diluted (1:1) extraction time 24 hours. Analyses made in triple frequency, results statistically processed with application of the Excel program – 2013.

RESULTS AND DISCUSSION

The contents of HM in soils of pasturable grounds of Khangalassky region

The special place among manifestations of anthropogenic impact on soils belongs to pollution of the territory heavy metals as fast self-cleaning of soils in the conditions of permafrost from metal pollution to the level demanded on hygienic and ecological safety is complicated [21].

According to the generalized scheme of soil geographical zoning (the Soils of the USSR, 1979), the zone of island and continuous distribution of permafrost within the North West - the Siberian lowland belongs to the West Siberian province gley weak-calx and undercalx and illuvial-humus soils of the Central taiga and forest region [10, 11].

Khangalassky region (the Central Yakutia) is generally located in a distribution zone of Permafrost cespitose and meadow types of soils on which grows the meadow vegetation [22].

The results of our researches showed that in pasturable meadows of Tekhtur village the maintenance of a humus varied from 3,2% to 10,2%, acidity of soils fluctuated from 6,5 – 7,5 (the subacidic and alkaline environment). Lead level in the soil fluctuated from 0,02mkg/g to 0,15 mkg/g, cadmium - 0,005 mkg/g to 0,02 mkg/g, zinc - 0,24 mkg/g to 0,45 mkg/g and copper - 0,10 mkg/g to 0,25 mkg/g.

In accordance with the data in table 1, in soils of pasturable grounds of Tekhtur village is the greatest accumulation of mobile connections zinc, the smallest cadmium. (tabl. 1)

Table 1

Concentration of HM in the soil of pasturable meadows of the Hangalassky region of the village of Tekhtyur

Heavy metals	MPC	Distance from a highway				
		Tekhtyur	5 m leftside	5 m rightside	200 m rightside	250m leftside
Pb, mgk/g	6	0,08±0,01	0,15*±0,03	0,14±0,02	0,10±0,03	0,02*±0,01
Cd, mgk/g	-	0,01±0,001	0,02±0,001	0,02±0,001	0,01±0,001	0,005±0,003
Zn, mgk/g	23	0,32±0,03	0,45*±0,05	0,42±0,03	0,37±0,03	0,24*±0,02
Cu, mgk/g	3	0,10±0,01	0,25±0,02	0,23±0,01	0,15±0,02	0,10*±0,01

Note: in Tables 1 and 2 * $p < 0.05$ in comparison of 5 m from a highway

Concentration of HM depended on distance from a highway. In 5 m from a highway of concentration of all four elements were higher, than at distance of 200-250 m. Thus the TM level in the soil was distributed in decreasing order of Zn >Cu>Pb> Cd.

However, bioaccumulation of HM and their mobility is defined by size pH and the maintenance of a humus in the alkalescent environment with decrease pH ion-exchange absorption of cationic forms of the pollutants getting to the soil considerably accrues; at anion forms inverse relationship is shown - their main weight is occluded in the alkalescent environment in which anions in a two-charging form prevail [16].

Possibly, high concentration of zinc in the soil, is connected by that zinc is an essentially microcell for soils, plants and the person. Besides, he treats elements kindly soluble in the soil. With a humus this element forms steady connections. Zinc adsorption by the soil depends from pH. In the alkaline environment zinc is adsorbed on the hemosorbtion mechanism, and in the sour environment there is a kationo-exchange absorption. At the increased acidity the share of mobile zinc. Most fully zinc is absorbed by iron oxides [12, 18].

Rather high concentration of copper it is also connected with pH. As in alkalescent and even to the neutral environment copper for a long time is late in the soil. However at the raised contents copper makes toxic impact, both on plants, and on the subsequent components of a food chain, including the person, and can be the cause of various chronic diseases [20].

In soils of pasturable meadows of the village Nemyugyu the humus varied from 1,8% to 3,6%, acidity of soils fluctuated from 7,5 to 8,5.

Accumulation and distribution of the elements determined by soils of the village Nemyugyu had the same regularity, as well as in soils of the village of Tekhtyur (tabl. 2).

Table 2

Concentration of HM in the soil of pasturable meadows of the Hangalassky region of the village Nemyugyu

Heavy metals	MPC	Distance from a highway				
		Nemyugyu	5 m leftside	5 m rightside	80 m rightside	300 m leftside
Pb, mgk/g	6	0,14±0,01	0,28*±0,02	0,25±0,01	0,15±0,02	0,04*±0,01
Cd, mgk/g	-	0,02±0,01	0,04±0,01	0,05±0,02	0,02±0,01	0,01±0,001
Zn, mgk/g	23	0,94±0,05	1,95*±0,10	1,90±0,11	0,52±0,05	0,44*±0,06
Cu,mgk/g	3	0,16±0,02	0,43*±0,03	0,42±0,03	0,19±0,01	0,15*±0,02

Data presented in table 2 testify that the HM level on pastures of the village Nemyugyu was statistically authentically higher, than in pastures of the village of Tekhtyur. Zinc was more in the soil in Nemyugyu 2,9 times, copper – 1,6 times, cadmium – 2 time, lead – 1,7 times.

Higher content of heavy metals in pasturable meadows in Nemyugyu village can be connected with populous (population of the village Nemyugyu 3,6 times higher, than the village of Tekhtyur) and with a close arrangement with Pokrovsk (7 km). On this interval of the republican road loading is raised a transport stream.

Results of our researches testify that the pasture of cattle in close proximity to a highway can be the prerequisite of impurity of animal husbandry products by heavy metals.

As a result of analyses of samples of the soils selected in the Khangalassky region showed that concentration of Pb, Cd, Cu, Zn in a soil cover of pasturable grounds of the village of Tekhtyur and village Nemyugyu don't exceed the established sanitary and hygienic standards [1, 2, 19].

The maintenance of HM in fodder herbs of pasturable grounds of the Khangalassky region. Plants are the second important factor on the way of movement of heavy metals on a food chain in a human body. Root systems are capable to keep rather big quantity of ions that is connected with cumulative action of morphological structures and chemical reactions of the nonspecific nature which treat the exchange capacity of roots, concentration of metals in vacuoles, a chemical inactivation of specific connections [17].

Vegetable forages are the important power supply for animals, both in summer, and in winter time, and impurity of forages of HM is reflected not only in animals, but also in human health. It is already proved that such elements as cadmium and lead are carcinogens. According to medical statistics of Republic of the Sakha (Yakutia) mortality from oncological diseases for the last five years increased more, than twice [8].

In tables 3 and 4 presented a data about the contents of HM in fodder herbs of pastures of the village of Tekhtyur and village Nemyugyu. Concentration of lead in meadow herbs fluctuated from 0,10 mg/kg to 0,15 mg/kg, zinc from 31,34 mg/kg to 42,70 mg/kg, copper from 7,80 to 15,23 mg/kg, and cadmium was found only in the item Tekhtyur (tabl. 3).

Table 3

Concentration of HM in fodder herbs of pasturable meadows of the Hangalassky region of the village of Tekhtyur

Heavy metals	MPC	Distance from a highway				
		Tekhtyur	5 m left side	5 m right side	200 m right side	250 m left side
Pb, mg/kg	5,0	0,15±0,02	0,11±0,05	0,10±0,03	0,21±0,03	0,10±0,02
Cd, mg/kg	0,5	0,01±0,00	0	0	0	0
Zn, mg/kg	10-50,0*	31,34±0,11	34,49±0,18	42,70±0,20	39,46±0,23	31,98±0,17
Cu, mg/kg	1,0-10*	10,55±0,15	7,80±0,10	15,23±0,12	11,18±0,12	8,16±0,11

The greatest accumulation of heavy metals in fodder herbs was revealed in 5 m from a highway, the smallest - in 250 m. In the herbs growing in the item Tekhtyur and in 200 m from the road on the right side the level of copper corresponded to the upper bound of maximum concentration limit. The results received that do not contradict literary data [20, 21].

Table 4

Concentration of HM in fodder herbs of pasturable meadows of the Hangalassky region of the village of Nemyugyu

Heavy metals	MPC	Distance from a highway				
		Nemyugyu	5 m left side	5 m right side	80 m right side	300 m left side
Pb, mg/kg	5,0	0,26±0,05	0,35±0,08	0,22±0,05	0,25±0,06	0,38±0,03
Cd, mg/kg	0,5	0,01±0,00	0,01±0,00	-	0,01±0,00	0,02±0,00
Zn, mg/kg	10-50,0*	50,83±0,18	85,84±0,21	61,86±0,40	47,87±0,24	36,16±0,23
Cu, mg/kg	1,0-10*	13,50±0,11	19,23±0,14	16,64±0,13	26,12±0,15	25,39±0,17

High concentration of lead in 300 m of the left side from a village Nemyugyu highway, it is possibly caused by anthropogenic factors: motor transport of local population. Unlike the village of Tekhtyur in herbs of pastures of the village Nemyugyu cadmium was found. However it is concentration were much lower than maximum concentration limit (tabl. 4).

Distribution of concentration of HM in vegetable sterns of the village Nemyugyu and Tekhtyur had the same character, as well as in soils of pastures: Zn>Cu>Pb>Cd. That is the level of microcells in plants directly depends on their contents in the soil in which they grow. This fact shows that the prerequisite of ecological safety of animal husbandry products is monitoring of element structure of soils.

High levels of zinc and copper in plants are caused to their physiological meaning. Copper in plants plays an important role in oxidation-reduction processes, improves intensity of photosynthesis, and promotes formation of chlorophyll. Zinc in a vegetable organism activates 30 fermental systems in a cell. In plants, along with participation in breath, proteinaceous, carbohydrate and nucleinic exchanges, zinc regulates growth, influences formation of amino acid of tryptophane and raises the maintenance of phytohormones. Zinc is necessary for normal development of an ovum and a germ of plants. It raises hot-, warm- and cold constancy of plants, and a physiological role of copper in a vegetable organism is closely connected with its participation in the fermentativnykh processes directly as catalyst or as a part of cupriferous enzymes. It increases intensity of breath, catalyzes oxidation of ascorbic acid, provides assimilation of nitrate nitrogen and fixing of nitrogen of the atmosphere. Copper is necessary to plants for formation of chlorophyll, participates in a metabolism of proteins and carbohydrates [1, 2, 21].

Excess of maximum concentration limit of copper and zinc in fodder herbs leads to increase in their contents in an organism of pets. High concentration of copper and zinc in muscular tissue and in bodies of cattle can debalance metabolic balance of other metals that can break activity of many enzymes and a metabolism, leading to pathology not only animals, but also the person. Disbalance of the relation copper/zinc is the main causal factor in development of coronary heart disease. At increase in level of copper in a human body there is growth stop, гемолиз, and decrease in the content of hemoglobin, degradation of tissues of liver, kidneys and a brain [21].

Thus, determination of level of heavy metals in the soil and fodder plants is necessary for environmental monitoring of environment. As heavy metals on a food chain get to a human body and there can be the reason do not adaptation of violations and pathological conditions of the person in the north.

CONCLUSIONS

1. It is established that in soils of pasturable grounds of the village of Tekhtyur and the village Nemyugyu of the Khangalassky region concentration of Pb, Cd, Zn and Cu don't exceed maximum concentration limit.

2. Concentration of heavy metals depends on distance from a highway: in 5 m of concentration of all four elements were higher, than at distance of 200 - 300 m.

3. It is revealed that contents of Pb, Cd, Zn, Cu in fodder herbs of pastures of the village of Tekhtyur and village Nemyugyu depended on their concentration in the soil. This level of cadmium and lead in plants isn't exceeded by maximum concentration limit, and concentration of zinc and copper in 5 m of a highway exceeded maximum concentration limit.

REFERENCES

1. Bityutsky N.P. Neobkhodimye mikroelementy rasteny [Necessary microelements of plants] SPb.: Izd-vo DEAN, 2005, 256 p.
2. Bityutsky N.P. Mikroelementy vysshikh rasteny [Microelements of the higher plants] – SPb.: Izd-vo S.- Peterb. un-ta [SPb.: SPb. publishing house - Peterb. un-t,]. 2011, 368 p.
3. GOST 28168-89 Pochvy. Otbor prob. [GOST 28168-89 of the Soil. Sampling.], M.: Izdatelstvo standartov [M.: Sandards Publishing House], 1989, 7 p.
4. GOST 26929-94 Syrye i produkty pishchevye. Podgotovka prob. Mineralizatsiya dlya opredeleniya soderzhaniya toksichnykh elementov. [GOST 26929-94 Raw materials and foodstuff. Preparation of tests. A mineralization for definition of the maintenance of toxic elements.] Minsk, 1995, 12 p.
5. GOST 30178-96 Syrye i produkty pishchevye. Atomno-absorbtsionny metod opredeleniya toksichnykh elementov. [GOST 30178-96 Raw materials and foodstuff. Nuclear and absorbing method of definition of toxic elements] Moscow, 2010, 10 p.
6. GOST 26213-94 Pochvy. Metody opredeleniya organicheskogo veshchestva. [GOST of 26213-94 Soils. Methods of definition of organic substance]. Moscow, 2011, 8 p.

7. GOST 26423-85 Pochvy. Metody opredeleniya udelnoy elektricheskoy provodimosti, pH i plotnogo ostatka vodnoy vytyazhki. [GOST 26423-85 of the Soil. Methods of determination of specific electric conductivity, pH and dense rest of a water extract]. Moscow, 1985. 7 p.
8. Gosudarstvenny doklad o sostoyanii zdorovya naseleniya Respubliki Sakha (Yakutiya) v 2009 godu / Ministerstvo zdravookhraneniya RS (Ya), GU «Yakutsky respublikansky informatsionno-analitichesky tsentr» [The state report on a state of health of the population of the Republic of Sakha (Yakutia) in 2009 year / Ministry of Health of Republic of Sakha (Yakutia), GU "Yakut Republican Information and Analysis Center"] an edition L.I. Verbitskaya [red. L.I. Verbitskaya]. Yakutsk, 2010, 120 p.
9. Gosudarstvenny doklad «O sostoyanii i ob okhrane okruzhayushchey sredy Rossyskoy Federatsii 2014» [The state report "About a state and about environmental protection of the Russian Federation 2014"] Ministerstvo prirodnykh resursov Rossyskoy Federatsii, [the Ministry of natural resources of the Russian Federation], Moscow, 2015.
10. Yelovskaya L.G. Klassifikatsiya i diagnostika merzlotnykh pochv Yakutii [Classification and diagnostics cryosolic of soils of Yakutia], YaF SO AN SSSR [YaF FROM Academy of Sciences of the USSR], 1987, 172 p.
11. Yelovskaya L.G. Pochvy zemledelcheskikh rayonov Yakutii i puti povysheniya plodorodiya [Soils of the agricultural regions of Yakutia and way of increase of fertility]. Kn. izd-vo [Book publishing house], Yakutsk, 1964, 76 p.
12. Yegorov A.D. Mikroelementy v pochvakh i lugopastbishchnykh rasteniyakh merzlotnykh landshaftov Yakutii [Microelements in soils and the grassland plants the cryosolic of landscapes of Yakutia]. – Yakutsk: Yakut. Kn. Izd-vo, 1970. – IKh ch. – 288 s.– Yakutsk: Yakut. Book. Publishing house, 1970. – IX h. – 288 p.
13. Yegorov A.D. Osobennosti migratsii i akkumulyatsii mikroelementov v rastitelnosti Yakutii [Features of migration and accumulation of microelements in vegetation of Yakutia] Mikroelementy v selskom khozyaystve i meditsine. [Microcells in agriculture and medicine]. Ulan-Ude, 1966, V.1, p. 168-170.
14. Zhuykova T.V. Raznye strategii adaptatsii rasteny k toksicheskomu zagryazneniyu sredy tyazhelymi metallami (na primere Taraxacum officinale S.L) [Different strategy of adaptation of plants to toxic pollution of the environment heavy metals (on the example of Taraxacum officinale S.L.)] Ekologiya [Ecology]. 1999, №. 3, p. 189 – 196.

15. Ilyin V.B. Tyazhelye metally v sisteme pochva-rasteniye [Heavy metals in system the soil plant]. Novosibirsk: Nauka, 1991, 151 p.
16. Mikroelementy v okruzhayushchey srede. Biogeokhimiya, biotekhnologiya i bioremediatsiya [Microelements in environment. Biogeochemistry, biotechnology and bioremediation] / pod red. M.N. Prasada, K.S. Sadzhvana, R. Naydu [under the editorship of M. N. Prasad, K.S. Sadzhvan, R. Naidoo]. Moscow: Fizmatlit, 2009, 815 p.
17. Mikroelementy v okruzhayushchey srede [Microelement in environment] pod red. P.A. Vlasyuka. [Under the editorship of P. A. Vlasyuk]. Kiyev: Naukova dumka, 1980, 57 p.
18. Mineyev V.G. Tsink v okruzhayushchey srede [Tsink in environment] Agrokhimiya. [Agrochemistry]. 1984, № 3, P. 126-138.
19. Predelno dopustimye kontsentratsii (PDK) khimicheskikh veshchestv v pochve [The Maximum Permissible Concentration (MPC) of chemicals in the soil] Gigiyenicheskiye normativy GN 2.1.7.2041–06. [Hygienic standards of GN 2.1.7.2041-06]. 2006.
20. Rudakova E.V. Mikroelementy: postupleniye, transport i fiziologicheskiye funktsii v rasteniyakh [Microelements: receipt, transport and physiological functions in plants] otv. red. L.K. Ostrovskaya. AN USSR. In-t fiziologii rasteny. [Ed. L.K. Ostrovskaya. USSR AN. Ying t of physiology of plants.]. Kiyev: Nauk. Dumka , 1987, 180 p.
21. Savvinov D.D. Mikroelementy v severnykh ekosistemakh [Microelements in northern ecosystems]. Novosibirsk: Nauka, 2005, 288 p.
22. Savvinov D.D. Pochvy Yakutii: Problemy ratsionalnogo ispolzovaniya pochvennykh resursov [Soils of Yakutia: Problems of rational use of soil resources] Kn. izd-vo [Book publishing house], Yakutsk, 1989, 152p.

Contributions

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