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THE CONTENT OF MINERAL ELEMENTS AND HEAVY METALS IN THE WOOD OF PINE (PINUS SYLVESTRIS (L.) AND SPRUCE (PICEA ABIES (l.) KARST.)) IN SUBURBAN FORESTS OF ARKHANGELSK

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Abstract

On sample plots were selected samples of model trees. The defining of the content of mineral elements and heavy metals are made in the laboratory «Arctic».

Roentgenofluorescent analysis was performed by spectrometer LabCenterXRF-1800 with the use of crystal-analyzers. Preliminarily dried and crushed samples were merged in tablets.

Total content of mineral elements and heavy metals in spruce was higher than in pine wood. Content chemical elements in spruce depends on the category of the trees viability is the following picture: the deterioration of the trees there is a decrease in the calcium content of 0.05%. Sapwood and heartwood differ by total content of mineral elements and metals from pine to 1-2%. The content of mineral elements and heavy metals does not depend on the location of the cross-section in the tree trunk. For spruce the greatest concentration of chemical elements, including heavy metals, marked trees fifth category viability, first category viability - for pine. Stand near a highway has a more precarious situation of forest ecosystems. Deterioration of the trees there is a decrease in the calcium content of 0.05%. Sapwood and heartwood parts ate differs by its total content of mineral elements and metals from pine to 1-2%. The content of mineral elements and heavy metals not depends on the location of their cross-section of a tree trunk. The greatest concentration of chemical elements, including heavy metals, marked trees fifth category viability for spruce, first - for pine. Stand near highway has a more precarious situation of forest ecosystems.

Key words: Mineral elements, heavy metals, wood, category, the content, chemical analysis, sapwood, heartwood, spruce, pine

INTRODUCTION

The condition and sustainability of natural complexes depends on the character of anthropogenic effects and properties of these natural complexes and their components. Changes of natural ecosystems is a gradual process and morphologically notably seen have advanced, easy to reverse the stages of degeneration of nature (Flowers 1995). In recent decades the problem of mass dying of forests takes on the character into ecological catastrophe. Considering this question, most experts have come to the conclusion that complex factors leading to large-scale deterioration of forest condition are mostly crucial to pollution, and the rest only exacerbate the negative impacts (Vasilieva et al. 2000). Along with other factors the category of state of a tree is connected with trunk temperature (Ovsyannikova, Kiliusheva & Feklistov 2012).

Studying the status of forest ecosystems in terms of air pollution and the methods of solving this problem is discussed in several papers (Norin & Yarmishko 1990, Lukina & Nikonov 1993)

In forest biogeocenoses in edificatory are woody plants, organs and parts which differ in ash content and chemical structure (Lukina, Sukhareva, & Isaeva 2005). In heartwood trees average 10% of the cells are alive sapwood and heartwood is dead, with almost finished lignification and limited participation in physiological processes (Kramer & Kozlovsky 1960).

The study was conducted in Isakogorka precinct Arkhangelsk forestry forestry in the Primorsky district of the Arkhangelsk region (North taiga subzone). Just was founded on the 5th of plots in the bilberry spruce forest fresh and 5 - in the pine fresh blueberry. Plots have been established in BlackBerry spruce forests and Vaccinium myrtillus pine forests. All study plantations belong to class IV class, some are a birch. The age of the spruce is within the IV-V class of age, pine stands of class III-IV age. On each plot 15 were chosen randomly trees. The selection is made in a period of intense growth in June-August. The condition of the trees was estimated visually on the standard scale sanitation. In these areas were studied the content of mineral elements and heavy metals in the wood of the trees, as well as the correlation of chemical elements and conditions of trees. These areas are located at different distances from the source of contamination (road), namely: the three trial areas at a distance of 500 m and two plots - 1000 m for each tree species.

Selection and laying temporary plots was carried out taking into account requirements of IST 56-69-83 (State committee USSR on forestry 1983) and described methods (Anuchin 2004). Assessment of the status categories trees were conducted according to the «Sanitary rules in forests of the Russian Federation» approved by Order of the MNR of Russia from 27.12.2005. Assessment of forest condition was set by the method developed by B. I. Kovalev (Kovalev 2000).

On sample plots were selected samples of model trees. Model trees were selected according to the medium diameter and height, established according to the very rare on sample plots, as well as according to the category the condition of the trees (table 1).

Table 1 The average diameter and height on plots

Spruce			Pine		
№ plot	Average diameter, cm	Average height, m	№ plot	Average diameter, cm	Average height, m
1	17,0	15,9	1	16,3	14,5
2	16,5	14,8	2	15,4	13,6
3	16,8	15,4	3	15,8	13,9
4	16,4	14,9	4	16,4	14,8
5	16,9	15,6	5	16,0	14,1

With each model tree samples were taken for this purpose age drill of Pressler from a height of 1.3 meters were taken cores. Later in laboratory conditions, each sample was dried up completely dry in a drying case at temperature +105 C during the day. To transfer samples for analysis was necessary to chop the wood, sapwood and heartwood each category status. The total number of samples was 50 pieces.

The work on defining the content of mineral elements and heavy metals are made on the equipment of the laboratory «Arctic» (Northern (Arctic) Federal University named after Lomonosov) with the financial support of Minobrnauki Russia.

Roentgenofluorescent analysis was performed by spectrometer LabCenterXRF-1800. For chemical analysis of samples required to prepare the collected material. For this pre-dried and ground samples were merged into tablets.

First recorded range of sample and determine which elements are present in the sample, which then was determined by the method of fundamental parameters. Conditions of measurement: x-ray tube with rhodium-anode; U=40 kV and I= 95 mA, exposure with 40 and 20 with the background for points. The analysis was conducted in the atmosphere of the vacuum. For data logging in radiation used scintillation and proportional detectors.

It should be noted, that the total content of mineral elements and heavy metals in spruce timber is higher than in the pine wood (figure 1).

Considering the content of mineral elements, depending on the category of the viability of trees it should be noted that the greatest content of their celebrated in trees V category – for spruce, I category – for pine (figures 2 & 3).

Content in spruce chemical elements depending on the category of the viability of trees is the following picture: the deterioration of the trees there is a decrease in the calcium content of 0.05%.

Sapwood ate differs by its total content of mineral elements and metals from pine less than 1%, heartwood ate - by 1.5%.

Change the content in the sapwood and heartwood spruce and pine such minerals as calcium, potassium is low (tables 2,3,4 & 5) not more than 0,01%. The other elements are: sulphur, phosphorus, magnesium changes wood marked minimum. Considering the presence of heavy metals in the spruce it should be noted their minimum content of not more than 0.01% (tables 6 & 7). Therefore, the content of mineral elements and heavy metals not depends on the location of their cross-section of a tree trunk.

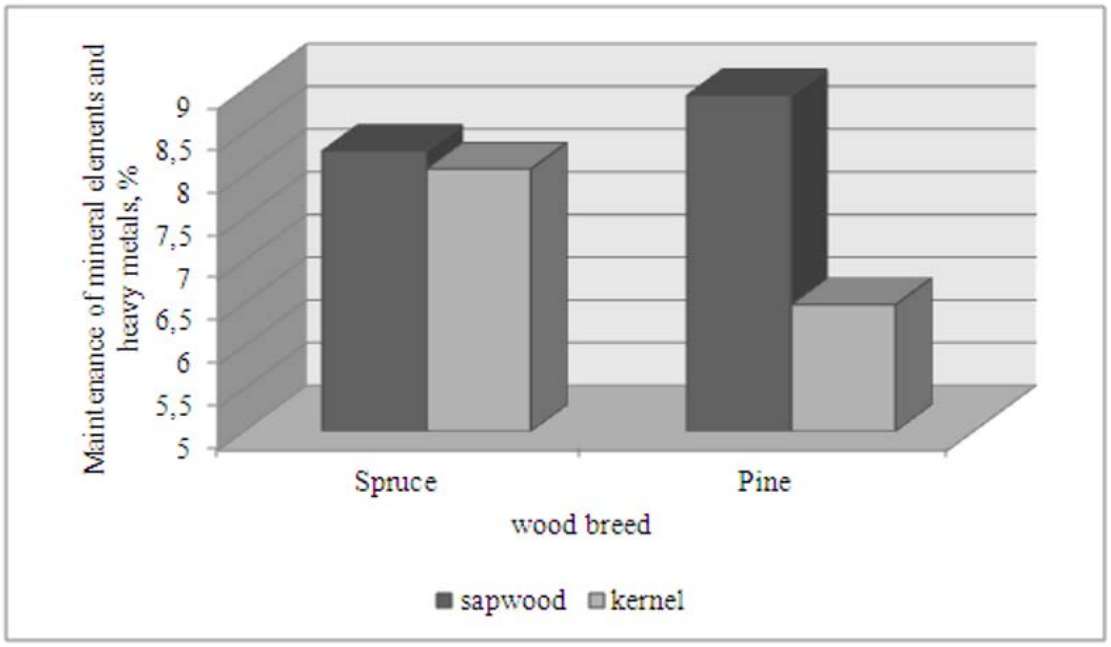


Figure 1 – The content of mineral elements and heavy metals in timber of spruce and pine

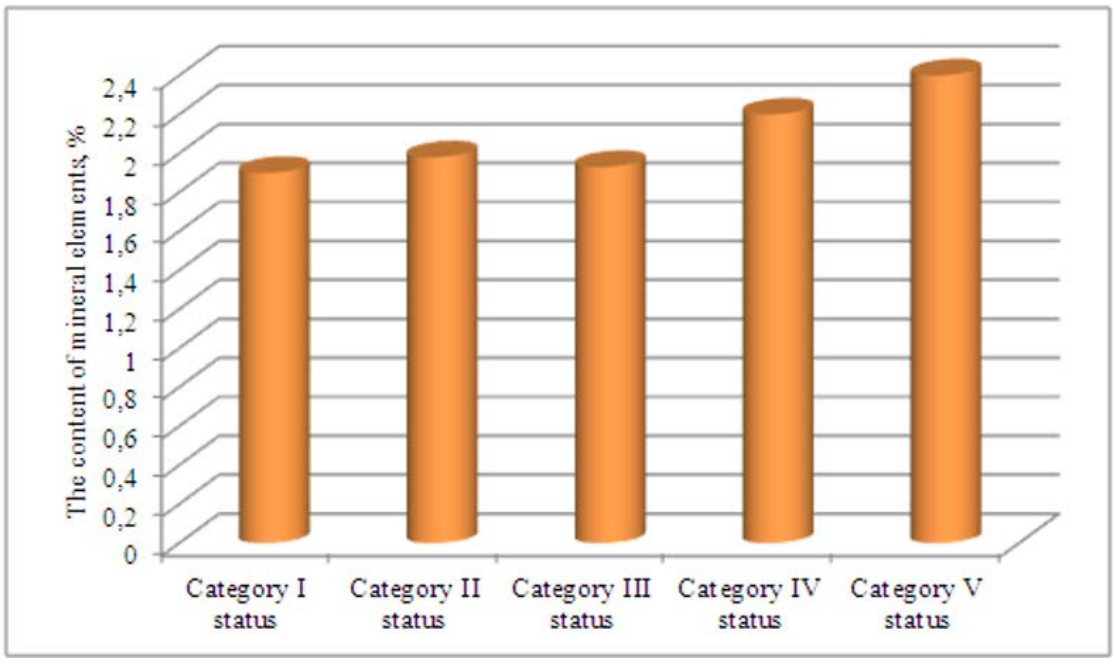


Figure 2 - The content of mineral elements categories viability in spruce

Table 2 - The content of mineral elements in the heartwood of the spruce

Statistical indicators	Mineral elements					
	Potassium	Sulfur	Phosphorus	Calcium	Magnesium	Zinc
Average value	0,082	0,012	0,005	0,249	0,031	0,002
Basic error	0,01	0,0004	0,0004	0,002	0,001	0,0002
Standard deviation	0,06	0,002	0,002	0,01	0,004	0,001
The coefficient of variation, %	73	18	40	4	12	50
The accuracy of experience, %	12,2	3,6	8,0	0,8	3,2	10,0
Reliability	8,2	27,5	12,5	124,5	31,0	10,0

Table 3 - The content of mineral elements in the sapwood of the spruce

Statistical indicators	Mineral elements					
	Potassium	Sulfur	Phosphorus	Calcium	Magnesium	Zinc
Average value	0,079	0,011	0,007	0,248	0,032	0,003
Basic error	0,01	0,0004	0,0004	0,004	0,001	0,0002
Standard deviation	0,05	0,002	0,002	0,02	0,004	0,001
The coefficient of variation, %	63	16	28,6	8	12	33
The accuracy of experience, %	12,6	3,3	5,7	1,6	3,1	6,7
Reliability	7,9	30,0	17,5	62,0	32,0	15,0

Table 4 – The content of mineral elements in the heartwood of the pine

Statistical indicators	Mineral elements					
	Potassium	Sulfur	Phosphorus	Calcium	Magnesium	Zinc
Average value	0,06	0,01	0,01	0,14	0,04	0,01
Basic error	0	0	0	0,01	0,01	0
Standard deviation	0,012	0,004	0,002	0,028	0,015	0
The coefficient of variation, %	22	31	40	20	35	31
The accuracy of experience, %	6,9	11	14,1	7	12,3	10,9
Reliability	14,5	9,09	7,09	14,35	8,12	9,15

Table 5 – The content of mineral elements in the sapwood of the pine

Statistical indicators	Mineral elements					
	Potassium	Sulfur	Phosphorus	Calcium	Magnesium	Zinc
Average value	0,08	0,01	0,01	0,22	0,04	0,004
Basic error	0,01	0	0	0,05	0	0
Standard deviation	0,017	0,004	0,003	0,13	0,005	0,006
The coefficient of variation, %	22	31	35	58	14	144
The accuracy of experience, %	7,9	10,8	12,2	20,4	4,9	51
Reliability	12,7	9,2	8,2	4,9	20,4	2

Table 6 – The content of heavy metals in timber of spruce

Statistical indicators	Mineral elements and heavy metals			
	Copper		Lead	
	heartwood	sapwood	heartwood	sapwood
Average value	0,009	0,006	0,0001	0,0002
Basic error	0,001	0,002	0,23	1,72
Standard deviation	0,005	0,007	1,02	7,74
The coefficient of variation, %	56	117	-	-
The accuracy of experience, %	11,1	33,3	-	-
Reliability	9,0	3,0	0	0

Table 7 – The content of heavy metals in timber of pine

Statistical indicators	Mineral elements and heavy metals			
	Copper		Lead	
	heartwood	sapwood	heartwood	sapwood
Average value	0,04	0,04	0,003	0,002
Basic error	0,01	0,02	0	0
Standard deviation	0,04	0,046	0	0
The coefficient of variation, %	102	122	88	73
The accuracy of experience, %	36,1	43,1	31	25,8
Reliability	2,77	2,3	3,23	3,9

The content of potassium, sulfur, phosphorus, and magnesium insignificant (up to 0,01%) and are almost constant values for all categories of the viability of trees. The marked increase in the content of such heavy metals such as zinc and copper, as the deterioration of the trees, but the overall magnitude of these indicators are the background and does not represent a threat to plantations.



Figure 2 - The content of mineral elements categories viability in timber of pines

In five pilot areas (for spruce stands) assessed the status of forests. It is established that two plots located at a distance of 500 meters from the highway II have the degree of changes in condition of forests (the rate of change of status is 0.67 and 0.59). The third plot assigned to 3rd degree, as evidenced by the light green colour of needles found the trees thinned with the crown, the rate of change of the status for this trial area is 0.52. It can be assumed that this situation is due to close fit of the road to the studied forest stands.

Two plots located at a distance of a 1000 meters from the highway, I belong to the extent of changes in forest conditions, evidenced by the coefficient of status changes (0.84), greenish-yellow colour of needles. Therefore, these plots are characterized by a strong market position of forest ecosystems.

CONCLUSIONS

According to the research results we can draw the following conclusions:

the total content of mineral elements and heavy metals in spruce timber is higher than in the pine wood;

the sapwood ate differs by its total content of mineral elements and metals from pine less than 1%;

the heartwood ate differs by its total content of mineral elements and metals from pine to 1.5%;

the content of mineral elements and heavy metals does not depend on their location in the cross section of a tree trunk;

the greatest content of chemical elements including heavy metals noted in the trees fifth category viability for spruce, first category viability for pine;

the forest stand is located near the motorway, has a more precarious situation of forest ecosystems and noted a higher content of heavy metals.

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