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Wood waste of forest industry of siberia for feeding cows

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Abstract. Full realization of genetic potential of productivity of livestock in the conditions of industrial technologies is impossible without using in its diets of various biologically active additives providing increase in productivity and standardization of indicators of homeostasis. The research has been conducted in “Breeding Farm Tazhny” Ltd, Sukhobuzimsky territory of Krasnoyarsk region. The influence of feeding coniferous flour and pine nut shells on milk productivity of black-motley breed cows at the age of the second calving has been studied. Three groups of 5 cows in each were formed. The period of the experiment lasted 100 days. As a result, the analysis of composition of the studied feed additives, milk productivity, hematological and biochemical blood tests were made. Milk yield of the cows receiving coniferous flour in addition to the main diet was higher than in the control group by 13.5 %, and the cows receiving a shell of pine nut – by 4.3 %, in terms of basic fat content by 22.7-15.7 %, respectively. The increase of milk productivity by adding the coniferous flour allowed reducing the cost of 1 kg of milk by 2.2 rubles or 13.1 %, increase profits by 9.442 rubles or 36.5 %.

1. Introduction

Full realization of genetic potential of productivity of livestock in the conditions of industrial technologies is impossible without using in its diets of various biologically active additives providing increase in productivity and standardization of indicators of homeostasis [1, 2].

A significant role to reinforce the fodder base of animal husbandry, replenishing it with various feeds and nutrients can be presented with various wood wastes after the processing of forest resources [3]. Today the estimated volume of unused wood waste in the Russian Federation is 125.4 million m³, and the green foliage mass of trees is 21 million m³ [4].

Especially plenty of green foliage mass of coniferous trees is left at the cutting areas of the Krasnoyarsk region, where forest resources make up one-fifth of the resources of the country in whole. In the region green foliage waste is not practically used, although the volume of its harvesting can be up to 1.5 million tons per year [5]. For the purpose of their rational use, it is important to develop the direction of processing wood wastes into feed additives for livestock [6]. The amount of fodder that can be obtained from unused waste will exceed the overall need for it in a particular region [7].

The amount and availability of forest resources, their natural renewability and the possibility of year-round use allows considering them as an additional raw material base for fodder production [3]. Acerouse leaf (pine needles) is a raw material with a high content of carotene and vitamins B, C, K and D, is simply burned in large quantities meanwhile, the needles contain the maximum amount of vitamins in winter and spring while in animal husbandry there is the greatest deficiency of vitamin-rich forages [7, 8, 9]. Coniferous flour is rich in chlorophyll, xanthophyll and phytoncides which play an important role in metabolism, protect animals from intestinal diseases and have a bactericidal effect. In



addition, it contains sugar, glucose, fructose, pectin, tannins, cobalt, copper, manganese, zinc, iron. Mineral and vitamin nutrition complex of coniferous flour and the presence of easily fermented carbohydrates in its composition have a positive effect on the physiological state of animals, increases their productivity and improves reproduction functions [10, 11]. The digestibility of organic mass of natural pine needles reaches 80 % and it is characterized as a highly nutritious and easily digestible product [12]. Fir coniferous flour is recommended for feeding cattle and poultry in winter and spring as an alternative to synthetic additives [13].

One of the natural plant objects based on which is possible to obtain valuable feed additives and premixes for animals is Siberian cedar pine (cedar) and its non-wood raw material is pine nut [14, 15]. Since ancient times pine nuts have been used in human diet because of a large number of nutritious and healing characteristics which increase host defenses and fortify the immune system [16, 17, 18].

After processing pine nuts large volume of shells (about 60 % of the weight of the nut) must be utilized [14, 15].

Up today, in Russia, there is no systematic utilization of pine nut shells; as a result, it brings to accumulating large volumes of waste at processing places, causing the environmental harm to the nature [11]. Pine nut shell is a good secondary raw material and has a low cost [19, 20]. The main part of the cedar nut shell consists of carbohydrates, mainly fiber [21]. The minerals and a high content of carbohydrates in the shell of pine nuts is a source of carbohydrate and mineral complex and various organic substances necessary for the normal functioning of the animal body.

Coniferous flour and pine nut shell belong to the wood waste of renewable natural resources have little use in processed form, accumulating at harvesting places in large volumes; having a low cost, and containing nutrients and biologically active substances needed for the livestock. It is determined the choice of these raw materials as objects of research for the development of a new feed additive for livestock.

The purpose of research is to study the effect of coniferous flour and pine nut shells on milk efficiency and blood parameters of cows.

2. Materials and methods

The research has been conducted in "Breeding Farm Tazhny" Ltd, Sukhobuzimsky territory, Krasnoyarsk region. The influence of feeding coniferous flour and ground pine nut shells on milk yield, hematological and biochemical blood parameters of cows was studied. According to the results, the economic efficiency of the research was calculated. Pine boughs for coniferous flour production were harvested in an area located in the Krasnoyarsk forest-steppe zone. Coniferous boughs were subjected to extraction (to remove resins and harmful substances) with alcohol-toluene mixture and hot water on the extraction plant. The shell of cedar was crushed on a crusher. The size of the crushed shell particles did not exceed 4 mm. Preparation of coniferous flour and crushed pine nut shells, as well as, their analysis were carried out in the laboratory of physical and chemical biology of wood plants "Pogorelsky Bor", Forest Institute n. a. V. N. Sukachev SB RAS. The period of the experiment was 100 days. The control group received the main diet, the 1-st experimental group in addition to the main diet received pine nut flower at a dosage of 50 g/head/day, the 2-nd experimental group – crushed pine nut shell at a dosage of 50 g/head/day. The content of using additives was 0.2%.

The tested cows were tethered and kept in typical four-row barns. Milking was in individual stalls in the milk pipeline 2 times a day (in the morning and evening). All tested cows were clinically healthy. Preventive veterinary measures were carried out according to the scheme adopted in the farm. The studied additives were fed together with concentrates (in dry form) once a day before evening milking.

Milk productivity was being tested with the control milking every decade. Total milk yield was calculated as a sum of yields for three decades for the month, and then for 100 days.

Blood for biochemical and hematological tests was taken at the beginning and at the end of the experiment of each group from the subcaudal vein with the disposable vacuum tubes in the morning before feeding

The morphological composition of the blood was determined on the hematological blood analyzer "Abacus Junior 5 (Vet)". Biochemical composition of blood serum was determined by biochemical and enzyme immunoassay blood "Chem Well 2910 C" photometric method. Quality definition of components composition (volatile compounds) of the samples of coniferous flour and pine nut shell was performed on chromatography-mass-spectrometer "Agilent 5975C-7890A" made by Agilent company (USA) with the use of vapor-phase sampler Sampler HeadSpace G 1888 in the center of collective use of FIC KNC SO RAN.

3. Discussion of results

The crushed nut shell had a rich brown color and a strong smell of pine nuts. Coniferous flour had a yellow-green color and a strong smell of pine foliage. Physical and chemical parameters of coniferous flour and pine nut shells are shown in Fig. 1.

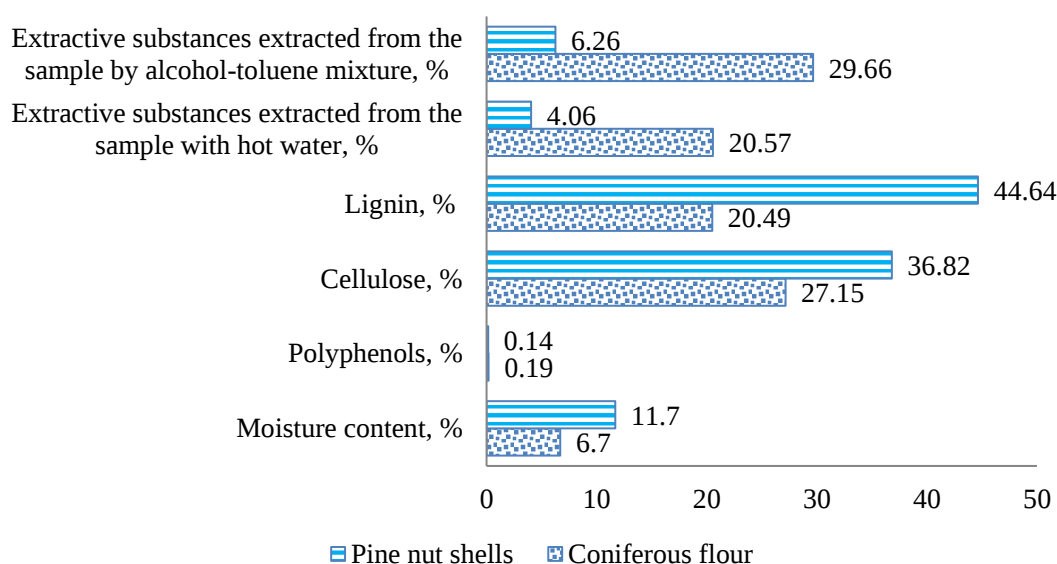


Figure 1. Physical and chemical parameters of coniferous flour and pine nut shells

On Fig. 1 it is shown that the coniferous flour contains more extractives on 23.4-16.51 %, polyphenols – 0.05% and less cellulose and lignin on 9.67 and 24.15 % than in pine nut shells. The data are confirmed by researchers [23].

Extractive substances extracted from the sample with hot water had no side effects on the organism of cows [24].

Considering the fact that pine nuts are formed during a two-year cycle of its development, it can be assumed that lignin of pine nut shells during this time is formed by aromatic compounds with a lower molecular weight than lignin of coniferous wood [21].

On Fig. 2 is shown the gross mineral content in coniferous flour and pine nut shells.

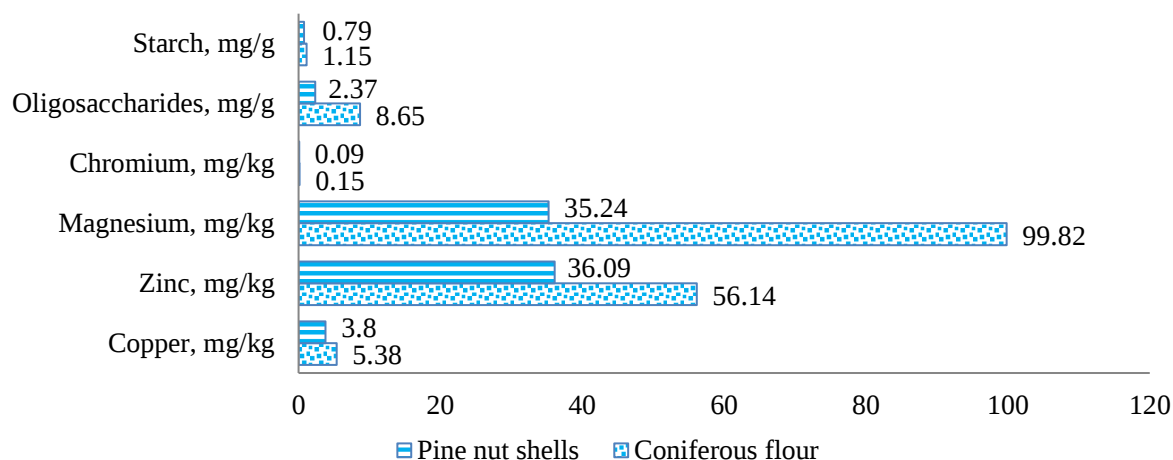


Figure 2. The gross content of mineral substances, carbohydrates and starch in a coniferous flour and pine nut shell

According to the results of the analysis, the content of copper, zinc, magnesium and chromium in coniferous flour was higher than in the shell of pine nuts by 29.4, 35.7, 64.7 and 40.0 %. It is also seen that the flour has more oligosaccharides and starch than in shell pine nut.

Thus, the study of physical and chemical parameters and composition of coniferous flour and pine nut shells demonstrates that they have a certain nutritional value, contain extractive, mineral, carbohydrates, starch, cellulose, lignin, which allows them to be used in feeding cows.

The main criterion for the valuable diet of cow is milk productivity. The yield during the period of the experiment is demonstrated in table 1.

Table 1. Milk productivity of cows

Indicator	Group		
	Control	1-st experimental	2-nd experimental
Milk-yield for 100 days of lactation, kg	2694.68±160.27	3114.40±146.70	2815.72±125.53
Average daily yield, kg	26.95±1.60	31.14±1.47	28.16±1.26
Mass fraction of fat, %	3.89±0.06	4.37±0.18	4.41±0.22*
Mass fraction of protein, %	3.01±0.06	3.05±0.02	3.07±0.05
Milk fat, kg	104.63	135.42	124.07
Milk protein, kg	81.10	94.97	86.65
Amount of milk basis fat (recalculated by 3,4 %), kg	3077.39	3982.9	3649.16

*P<0.05; **P<0.01; ***P<0.001, here and further

The maximum yield for 100 days of lactation was in 1-st experimental group (3114.40 kg) and was higher than in control group by 15.5 % (419.72 kg), 2-nd experimental group by 10.6 % (298.68 kg).

In terms of basic fat content, the amount of cow milk in the 1st experimental group was higher than in the control group by 29.42 % (905.51 kg), in the 2nd experimental group – by 9.14 % (333.74 kg). In the milk of first and second experimental groups the mass fraction of fat had no significant difference (0.9 %) and significantly superior to analogues of the control group by 12.3 and 13.4 % (P<0.05), correspondently.

The mass fraction of protein was higher in the milk of cows of the 2nd experimental group compared to the control group by 1.3 %, the 1st experimental group – by 0.7 %.

The increase of milk in the 1st experimental group is probably due to the fact that coniferous flour enriches diets with biologically active substances and micronutrients, optimizes the function of the gastrointestinal tract, activates motor-secretory activity of the intestine, enhances oxidation-reduction processes, prevents the inflammatory processes in the stomach and intestines, normalizes metabolism in animal's body [25].

The obtained data are corresponded with data of the scientists of B. O. Kirgintsev, A. E. Belenkloy, G. J. Yarmots (2017), stating that the acerouse leaf (pine needles) contains a complex of vitamins and minerals in an easily accessible form, and they are actively involved in the metabolism, which positively affects the physiological condition of the animals and increases productivity [11].

In research of Terentyev V. I and Anikienko T. I. (2011) was determined that feeding of coniferous flour to lactating cows increased milk productivity, improved vitamin content of milk, reproductive function and standardization of metabolism [13].

J. A. Pfister, K. E. Panther, D. R. Gardner, D. Cook, K. D. Welch (2008) in their studies found that the consumption of coniferous acerouse (pine needles) by cows depends on the balance of the protein diet. With an optimal ratio of protein and energy in the diet, the body of cows is able to better tolerate terpene substances contained in the acerouse leaf (pine needles) and, accordingly, consume more of it, whereas low protein content in the diet of cows consume coniferous flour at times less [26]. In our research animals consumed coniferous flour without remains.

Thus, the feeding of coniferous flour and pine nut shells had a positive impact on the milk productivity of cows, the mass fraction of fat and protein in milk.

The rate of metabolic processes characterizing the productive qualities of the animal is determined by biochemical parameters and blood composition. The results of biochemical blood tests of cows at the end of the experiment are shown in Fig. 3.

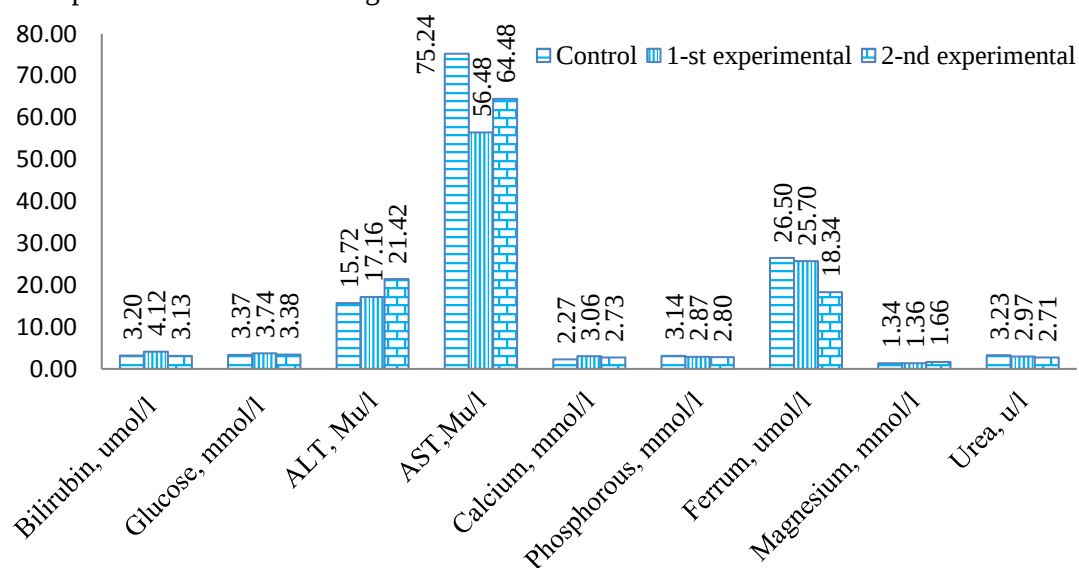


Figure 3. Biochemical blood parameters of cows

Analysis of the results of biochemical parameters showed that after 100 days of lactation the all blood indicators were within the physiological norm.

The concentration of calcium in the blood of cows of the experimental groups was higher than in the control group by 16.9 - 25.8 %, magnesium – by 1.5-19.3 %.

In research work of U. N. Prytkova, A. A. Kistina, N. U. Chervyakova (2015) is demonstrated that content of coniferous-energy feed additives of different dosages in the diet of heifers allowed to improve the mineral composition of the blood of animals [27].

Blood parameters can reflect changes that may result from changes in feeding conditions. Hematologic blood tests are shown in Fig. 4.

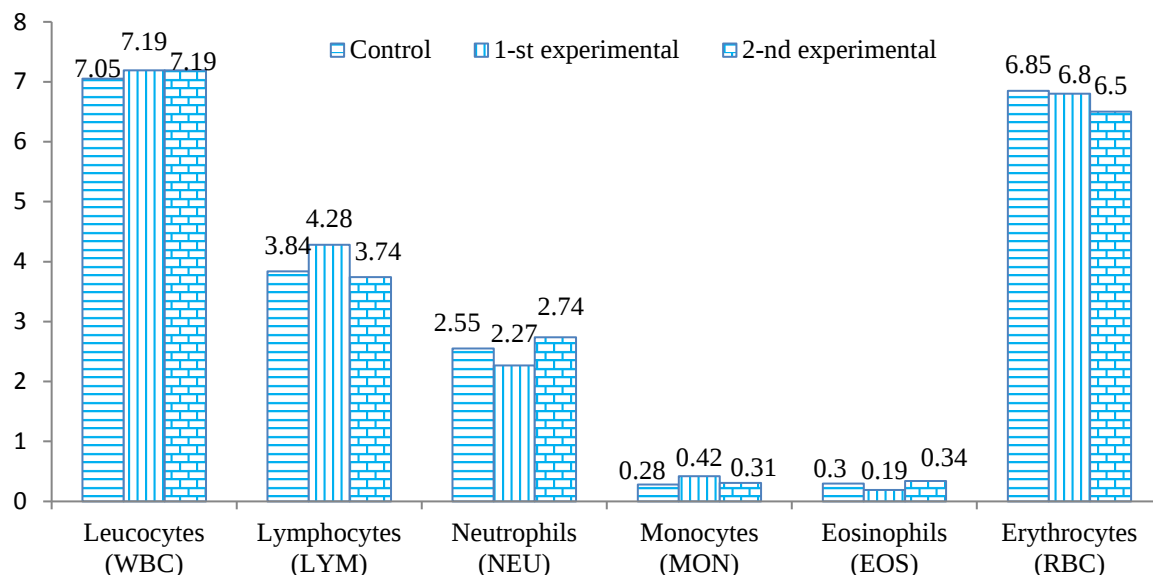


Figure 4. Hematologic blood examination

At the end of experiment the hematologic studies showed the highest content of leukocytes in animals of the 1st and 2nd experimental groups and exceeded the control indicators by 2.0 %. Cows of the 1st experimental group had the highest content of lymphocytes (4.28×10^9 CL/l) and monocytes (0.42×10^9 CL/l) in comparison with other groups. The number of neutrophils and eosinophils in animals of the 2nd experimental group exceeded the control group by 6.2 and 11.8 %, respectively. In the blood of cows in the control group, the level of red blood cells was higher than in the experimental groups by 0.7-5.1 %, respectively. It should be noted that with the exception of lymphocyte level, all the blood parameters were within the physiological norm.

Thus, the tested additives coniferous flour and crushed pine nut shells did not have a negative impact on the biochemical and hematologic parameters of the blood.

The calculation of economic efficiency showed that feeding cows with coniferous flour in amount of 50 g/head/day. (1st experimental group) was the most effective and allowed to reduce the cost of 1 kg of milk by 2.2 rubles or 13.1 %, increase profits by 9442.1 rubles or 36.5 % and the level of profitability by 20.6 %.

Thus, adding coniferous flour (50 g/head/day.) to the diet had a positive impact on milk production, biochemical and hematologic parameters of blood, allowed to increase the efficiency of milk production.

References

- [1] Ahmedkhanova R R and Hamidov N R 2010 the Use of aquatic organisms in the feeding of poultry *Problemy Razvitiya Regiona* **1** 73–7
- [2] Bagno O A, Shevchenko A et al 2018 Phytobiotic in animal farming *Agricultural Biology* **4(54)** 687–97
- [3] Borzunova A G and Zinovieva I S 2012 Complex processing of wood raw materials, utilization of wood waste *Successes of Modern Natural Sci.* **4** 180–1.

- [4] Dontsova T V 2017 Prospects for the use of forest bio-resources in animal farming innovations development of Russian science *Mater. of Int. Sci. Conf.* (Krasnoyarsk: Krasnoyarsk state agrarian University) 167–8
- [5] Kozina E A and Tabakov N A 2012 Products of processing of the wood in feeding of pigs Science and education: experience, problems, prospects of development *Mater. of Int. Sci. Conf.* (Krasnoyarsk: Krasnoyarsk state agrarian University) 244–7
- [6] Khomaza N S and Bernadiner I M 2010 *From a wood waste to fuel briquettes of solid waste* **11** 28–9
- [7] Krasilnikov O Y and Marinchenko T E 2018 Technologies that increase the profitability of feed production *Vestnik VNIIESH* **2** 109–14
- [8] Pakhomov V I, Braginets S V, Zakirov I V, et al 2018 Effectiveness of new technologies to fill the deficit of carotene in feed *Machinery and Equipment for the Village* **1** 18–20
- [9] Izmaylov A U, Lobachevsky Ya P, Marchenko O S and Tsench Yu S 2017 Creation of innovation technology and resource-saving technologies of production of forage – based livestock development *Bulletin of the Moscow State Agroengineering University* **6** 23–8
- [10] Ivanov E A, Tereshchenko V A, Ivanova O V and Larina N D 2018 Wood waste of Siberia in feeding dairy cows *Veterinary and Feeding* **5** 29–0
- [11] Kirgintsev B O, Belenkaya A E and Yarmots G A 2017 Use of needles in animal farming and the Integration of science and practice for the development of the agroindustrial complex *Articles Russ. Sci. Conf.* (Tyumen: FGBOU VO HAU Northern Zauralye) pp 229–34
- [12] Baranov N F, Fufachev V S and Stupin I V 2016 Justification and optimization of design and technological parameters of the shredder for the preparation of additives from coniferous boughs *Vestnik NGIEI* **6** 7–16
- [13] Terentyev V I and Anikienko T I 2011 Nutritional value and chemical composition of fir coniferous flour produced by LLC "EKOVID" *Vestnik Krasgau* **5** 163–6
- [14] Kiselev V P, Kuksa Y N and Efremov A A 2001 Possibilities of using shell of pine nut as a modifier of oil bitumen *Chem. of Vegetable Raw Mater.* **3** 59–3
- [15] Chen D et al 2016 Pyrolysis polygeneration of pine nut shell: Quality of pyrolysis products and study on the preparation of activated carbon from biochar *Bioresource Technol.* **216** 629–36
- [16] Lumbunov S G, Akhmetshakirova E Y and Eshizhamsoeva S B 2016 Husks of pine nuts – a biological additive in feeding calves *Vestnik of Buryat State Academy of Agriculture* **4** 135–9
- [17] Artamonov V I 1990 *Pine Siberian Sci. and life* **1** 158–60
- [18] Rush V A 1974 *Biochemical characteristics of cedar pine seeds Biology of seed propagation of coniferous species in Western Siberia* (Novosibirsk: Nauka) pp 180–7
- [19] Saveleva Y R, Kryazhnov A N, Bogomolov M S and Ivasenko V, L. 2003 Preparation of active carbon from the shell pine nut *Chem. of Vegetable Raw Mater.* **4** 61–4
- [20] Tereshchenko V A, Ivanov E A and Ivanova O I 2018 Milk production and blood parameters of cows while feeding of pine nut shells *Bull. of the Ulyanovsk State Agricultural Academy* **4** 205–9
- [21] Efremov A A, Pavlova E S, Offman K B and Krotova I V 1998 Production of cellulose-containing products from the shell of pine nuts in the conditions of the organosolvent method in the environment of acetic acid *Chem. of Vegetable Raw Mater.* **3** 87–91
- [22] Akhmedov D M, Irgashev T A and Kosilov B I 2016 Morphological and biochemical parameters blood of bulls of different genotypes *Izvestiya Orenburg GAU* **4** 219–21
- [23] Kim Y M, Kim S, Han T U, Park Y K and Watanabe C 2014 Pyrolysis reaction characteristics of Korean pine (*Pinus Koraiensis*) *J. of Analytical and Applied Pyrol.* **110** 435–41
- [24] James L F, Molyneux R J, Panter K E, Gardner D R and Stegelmeier B L 1994 Effect of feeding ponderosa needle extracts and their residues to pregnant cattle *Cornell Veterinarian* **84** 33–9
- [25] Vorobyev A L, Kalachev A A and Zalesov S V 2018 Use of wood wastes as raw material for obtaining fodder additives *Rus. Forestry* **3** 65–72

- [26] Pfister J A, Panter K E, Gardner D R, Cook D and Welch K D 2008 Effect of body condition on consumption of pine needles (*Pinus ponderosa*) by beef cow *J. of Animal Sci.* **86** 3608–16 doi: 10.2527/jas.2008-1000
- [27] Prytkov Y N, Kristina A A and Chervyakov M Yu 2015 the Efficacy of conifer-energy feed additive in dairy cattle *J. of Agricultural Sci.* **10** 17–20