Approbation of the technology for increasing the milk productivity of cows kept on rations with the addition of wastes from the alcohol industry

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Abstract. The purpose of this study was to test the technology for increasing the milk productivity of cows kept on rations with the addition of wastes from the alcohol industry (wheat stillage). The experiment was conducted on Simmental cows \( n = 30 \). The methodology involved feeding animals with wheat bard (40 l / animal) throughout the experiment and 60 days before the beginning of the study. Based on the comparison of elemental composition of wool with the “physiological norms”, the composition of mineral premix was calculated using 25 chemical elements and all animals were divided into two groups by the analogue method: control and experimental ones. The feeding and keeping conditions were identical. Cows of the experimental group additionally received correctable elements (Ca, Se, Zn, Mn) as part of the premix. Animals of the control group received the main diet. A four-month correction course normalized the elemental status indicators in animals of the experimental group for all correctable elements, including lead and strontium. The only exception was phosphorus whose concentration in the wool exceeded the upper limit by 1.7 times. At the same time, feeding wheat bard to cows of the control group was accompanied by the development of calcium, zinc, manganese, selenium and iodine dyselementoses. When correcting the elemental status of cows, there was a change in the antioxidant status of blood serum expressed in a decrease in the level of molon dialdehyde by 21.24 % and an increase in the activity of superoxide dismutase by 6.6 %. Differences in indicators of the morphological and biochemical composition of blood were established. In animals of the experimental group, milk yield and milk fat yield was higher by 7.2 %.

1. Introduction

Modern milk production is impossible without continuous monitoring of the health status of dairy cows, including the characteristics of mineral metabolism [1]. This becomes possible through the studies of mineral composition of biosubstrates, among which wool is considered [2, 3].

The experience gained in medicine shows that the use of an elemental analysis of hair to interpret the data obtained is possible after comparing them with the “physiological norm” – the content of chemical elements in hair [4]. The practice of using the method in dairy cattle breeding has not yet become widespread. This does not allow the full use of the genetic potential of highly productive cows with a high intensity of mineral metabolism.

In this regard, we carried out large-scale research on the development of technology for identifying and correcting the elemental status of cattle (Bos taurus). As part of these studies, a method for
sampling and studying the elemental composition of animal hair [5] was developed, the intervals of "physiological norms" of 25 chemical elements in the wool of animal meat [6] and dairy cattle [7] were determined, and the effect of exchange pools of essential and toxic elements on the productive qualities and physiological parameters of dairy cows was identified [8].

The paper describes the prospects of using the technology for identifying and correcting elementalosis in diets containing wheat bards.

2. Materials and methods

2.1. Research object

The studies were performed on a model of Simmental cows with a live weight of 450–500 kg. The stage of lactation was 30-55 days after calving. Experimental studies were carried out in accordance with the instructions and recommendations of the Order of the Ministry of Health of the USSR of July 27, 1978 No. 701 "On Amendments to the Order of the Ministry of Health of the USSR of 12.08.77 No. 755" and "The Guide for Care and Use of Laboratory Animals " (National Academy Press, Washington, DC 1996). Efforts were made to minimize animal suffering and reduce the number of samples used.

The studies were conducted in the farm "Falk N.G." (Orenburg region, Russia). The experimental part of the work was performed on Simmental cows (n = 30) and included two periods: preparatory (60 days) and accounting (120 days).

In the preparatory period, all animals were kept in similar conditions. Experimental animals received fresh wheat distillery in the amount of 40 l / day.

At the end of the preparatory period, wool samples were taken from all animals to study the elemental composition. The results obtained were compared with the "physiological norm" set at 25 and 75 percentiles for dairy cows [7], which made it possible to identify elementoses for individual chemical elements with the subsequent development of a mineral premix recipe for correcting the elemental status of animals.

Additionally, feed fodder in the amount of 90 g / animal was included in the diet of the experimental group; Zinc biocomplex was included in the amount of 5.6 mg / head (manufacturer: Alltech, Ltd, Ireland); Manganese Biocomplex – 5.3 mg / head (manufacturer: Alltech, Inc., Canada); Sel-Plex – 5.1 mg / head (manufacturer "Alltech flanders BVBA", Belgium).

For the experiment, animals were divided into two groups: control (n = 15) and experimental (n = 15) ones. Cows of the experimental group received corrective elements as part of the premix. The animals of the control group were given the main diet without premix.

2.2. Wool sampling and analysis

Samples of wool were taken from the upper part of withers using [5] stainless steel scissors. The elemental composition was studied using 25 indicators (Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, I, K, Li, Mg, Mn, Na, Ni, P, Pb, Se, Si, Sn, Sr, V, Zn) by the mass spectrometry (MS-ICP) and coupled plasma atomic emission spectrometry (ICP-AES) using Optima 2000 DV and Nexion 300 D (Perkin Elmer, USA). All analytical procedures were performed in the laboratory of the Center for Biotic Medicine (Moscow, Russia).

2.3. Sampling and analysis of medium milk samples

Cows were mechanically milked three times a day at 06.00, 14.00 and 18.00. Milk from each cow was weighed every ten days. Milk samples were taken from each cow three times a day during each milking, then they were placed in sterile containers, cooled (up to 5 °C) and sent for analysis to the Collective Use Center of the Federal Scientific Center for Biological Systems and Agricultural Technologies of the Russian Academy of Sciences. Studies of milk samples were conducted on the day of sampling.

Fat, protein and lactose content were evaluated using the FIL-IDF procedure on a MilkoScan™ FT1 instrument (Foss Electric, DK-3400, Hillerød, Denmark).
2.4. Blood sampling and analysis
Blood samples (9 ml) were taken from each cow (the day after milk sampling) from the tail vein into a vacuum tube at the beginning and end of the experiment. Morphological parameters of blood were evaluated on a URIT-2900 VetPlus automatic hematology analyzer (URIT Medical Electronic Co., Ltd, China). Serum biochemical composition was determined using a CS-T240 automatic biochemical analyzer (Dirui Industrial Co., Ltd, China) and commercial biochemical kits for veterinary medicine (DIAKON-DS, Russia; Randox Laboratories Ltd, Great Britain). Enzymatic activity in blood plasma was determined by the spectrophotometric method on Stat fax 1904 Plus. The concentration of malondialdehyde (Total-MDA) was determined in heparinized blood the spectrophotometric method [9]. The activity of the superoxide dismutase enzyme was judged by a decrease in hydrogen peroxide in the incubation medium. The concentration of hydrogen peroxide was determined by the reaction with ammonium molybdate.

2.5. Statistical analysis
Significance of differences was checked using the Mann-Whitney U test. The significance level (P) was less than or equal to 0.05. For data processing, Statistica 10.0 (StatSoft, Inc., USA) was used. The tables show the average values of indicators (M) and their standard deviations (± STD).

3. Results
An initial analysis of the elemental composition of wither hair 60 days after the inclusion of fresh bard in the diet revealed a decrease in the content of calcium, zinc, manganese, and selenium relative to the "physiological norm". An excess of phosphorus and toxic elements — lead and strontium — was observed (Fig. 1).

![Figure 1](image_url)

**Figure 1.** The multiplicity of deviations of concentrations of chemical elements in the wool of Simmental cows from the physiological norm 60 days after feeding with wheat stillage (the beginning of the experiment).

A four-month correction course with a mineral premix “normalized” the indicators of the elemental status for all correctable elements (Ca, Zn, Mn, Se), lead and strontium. The only exception was phosphorus whose concentration exceeded the upper limit by 1.7 times (Fig. 2).

In general, the average values of concentrations of elements in the wool significantly increased relative to the beginning of the experiment: for calcium — by 125 % (p≤0.001), for potassium — by 60.00 % (p≤0.05), for zinc — by 99.80 % (p≤0.001), for manganese — 100 % (p≤0.001), for selenium — 113.2 % (p≤0.001), for iodine — by 41.74 % (p≤0.05), for phosphorus — by 47.06 % (p≤0.05) and for strontium and lead, they decreased by 20.45 % (p≤0.05) and 30.77 (p≤0.05), respectively.
Figure 2. The multiplicity of deviations of concentrations of chemical elements in the wither wool of experimental cows from the “physiological norm” after the 4-month correction course.

Evaluation of the elemental status after four months of the experiment and subsequent interpretation of the data made it possible to establish that feeding raw wheat stillage aggravated the previously identified elementoses for calcium, zinc, manganese and selenium, and was accompanied by the development of iodine dyslementosis (Fig. 3). The concentration of the latter was below the border of the 25th percentile of the norm by 1.1 times.

Figure 3. The multiplicity of deviations of concentrations of chemical elements in the wither wool of control cows from the “physiological norm” at the end of the experiment.

In general, the elemental profile of cows of the control group was characterized by a decrease in the concentrations of the elements. The most significant decrease was observed for the exchange pools of iron (by 40.03 %; p≤0.01), silicon (by 33.33 %; p≤0.01), cobalt (by 30 %; p≤0.05), iodine (22.22 %; p≤0.01), calcium (21.67 %; p≤0.01), copper (20 %; p≤0.05), selenium (16.67 %; p≤0.01), zinc (15.79 %; p≤0.05), manganese (12.5 %; p≤0.05), magnesium (12.5 %; p≤0.05), chromium (12.00 %; p≤0.05) and potassium (11.11 %; p≤0.05). An exception was phosphorus, whose concentration increased by 15.38 % (p≤0.05).

The results of the biochemical study of blood serum showed that in the group of cows receiving a corrective additive, the content of total protein and albumin increased by 8.8 % (p≤0.05) and 10.4 % (p≤0.05), respectively (Table 1).
Table 1. Biochemical composition of blood serum in Simmental cows resulted from the addition of wheat bard

| Parameter                        | control                  | Group                        |
|----------------------------------|--------------------------|------------------------------|
|                                  | Beginning of the experiment | End of the experiment | Beginning of the experiment | End of the experiment |
| Total protein, g/l               | 68.2±7.72                | 62.0±8.65*                  | 67.0±6.95                   | 72.9±7.88*            |
| Albumin, g/l                     | 35.1±4.49                | 31.5±4.45*                  | 34.9±4.21                   | 38.5±4.84*            |
| ALT, Units / l                   | 35.8±6.32                | 37.6±6.34                   | 36.6±5.31                   | 31.5±6.80             |
| AST, Units / l                   | 92.9±10.27               | 96.5±10.23                  | 94.6±9.60                   | 93.6±19.30            |
| Total Bilirubin, mmol / l        | 9.8±2.525                | 9.9±1.422                   | 9.7±2.13                    | 8.1±1.77*             |
| Direct bilirubin, mmol / l       | 1.3±0.152                | 1.3±0.223                   | 1.26±0.140                  | 1.68±0.567            |
| Cholesterol, mmol / l            | 2.3±1.42                 | 2.3±1.98                    | 2.26±1.04                   | 2.98±0.826*           |
| Urea, mmol / l                   | 6.4±1.83                 | 6.2±1.68                    | 6.43±1.73                   | 6.5±1.857             |
| Glucose, mmol / l                | 2.1±0.623                | 2.1±0.636                   | 2.08±0.628                  | 2.59±0.658*           |
| Alkaline phosphatase, units / l  | 47.3±19.64               | 48.2±20.01                  | 46.2±18.53                  | 54.0±27.63            |

The difference in the ratio of indicators to the beginning of the experiment is significant at: *p≤0.05

By the end of the experiment, a decrease in total bilirubin by 16.8 % (p<0.05) occurred in the blood serum of cows of the experimental group. If we consider the ratio of direct and indirect bilirubin, by the end of the experiment it was 1: 5, and in the control group, it was 1: 7, which indicates the optimization of detoxification of the body.

After completion of the correction course, erythrocyte and hemoglobin concentrations in cows of the experimental group exceeded the ones in the control one by 16.2 % (p≤0.05) and 19.7 % (p <0.05), respectively (Table 2).

Table 2. Morphological composition of blood of cows of Simmental breed contained in diets with the addition of wheat bard

| Parameter                        | control                  | Group                        |
|----------------------------------|--------------------------|------------------------------|
|                                  | Beginning of the experiment | end of the experiment | Beginning of the experiment | End of the experiment |
| The number of leukocytes, 10⁹ cells / l | 7.5±1.82                 | 8.8±1.48*                   | 7.9±2.20                    | 6.5±1.48*             |
| The percentage of monocytes, %   | 17.7±3.9                 | 17.0±5.4                    | 17.6±2.7                    | 14.7±6.6              |
| The percentage of lymphocytes, 10⁹ cells/l | 2.8±1.03                 | 2.61±1.15                   | 2.81±1.03                   | 2.52±1.96             |
| The number of monocytes, 10⁹ cells / l | 1.4±0.515                | 1.1±0.632                   | 1.30±0.480                  | 0.967±0.614           |
| The number of red blood cells, 10¹² cells / l | 5.0±0.522                | 4.8±0.599                   | 5.10±0.577                  | 5.60±0.604*           |
| Hemoglobin concentration , g / l | 87.9±9.7                 | 80.2±12.4*                  | 85.9±10.5                   | 95.9±11.8*            |
| Hematocrit %                     | 23.9±4.2                 | 22.4±4.0                    | 24.2±3.6                    | 26.8±3.9              |
| The average volume of red blood cells, fl | 48.8±4.5                 | 49.5±5.7                    | 48.9±4.5                    | 51.0±6.6              |
| The average value of hemoglobin in the cell, pg | 15.9±1.1                 | 16.1±1.9                    | 16.7±1.1                    | 17.2±1.9              |
| Platelet count, 10⁹ cells / L    | 181.4±45.6               | 171.9±32.2                  | 176.8±67.1                  | 145.0±31.2            |
| The average volume of platelets, fl | 11.8±0.92                | 10.7±0.99                   | 10.5±0.88                   | 10.9±0.94             |
| The relative volume of platelets, % | 0.169±0.049              | 0.157±0.042                 | 0.172±0.067                 | 0.128±0.036*          |

The difference in the ratio of indicators to the beginning of the experiment is significant at: *p≤0.05

During correction of the elemental status of cows, a change in the indicators of the antioxidant status of blood serum occurred (Table 3).

In the experimental group, the level of malondialdehyde decreased by 21.24 % (p <0.05), while the values of this indicator were 23.76 % lower than the corresponding values in animals of the control group at the end of the experiment (p <0.05).
Table 3. Antioxidant status of blood serum in Simmental cows fed with grain stillage

| Parameter                        | Group                 | control          | experimental     |
|----------------------------------|-----------------------|------------------|------------------|
|                                  | Beginning of the      | End of the       | Beginning of the | End of the   |
|                                  | experiment            | experiment       | experiment       | experiment   |
| Superoxide dismutase, %          | 1851±444.7            | 1863±212.41      | 1829±283.8       | 1971±203.8*  |
| Catalase, μm                     | 4856±2888             | 4754±2224        | 4805±2968        | 4954±2146    |
| Malonic dialdehyde, nm / ml      | 55.64±15.07           | 57.62±11.55      | 55.78±12.78      | 43.93±13.04* |

The difference in the ratio of indicators to the beginning of the experiment is significant at: * – p≤0.05

At the end of the experiment, in cows of the experimental group, an increase in the activity of superoxide dismutase was 6.6 % (p <0.05), the difference between animals of the control and experimental groups was 5.8 % (p <0.05) in favor the latter.

The experiment established the fact of increasing productivity of cows (Table 4).

Table 4. Milk productivity of Simmental cows fed with wheat stillage for 305 days of lactation

| Parameter                        | Group       | control          | experimental     |
|----------------------------------|-------------|------------------|------------------|
|                                  |             |                  |                  |
| Milk yield 1 % by milk fat, kg   | control     | 16026 ± 1470     | 17190 ± 1511 *   |
| Fat content in milk, %           | experimental| 3.69 ± 0.275     | 3.85 ± 0.318     |
| Yield of milk fat, kg            | control     | 160.3 ± 15.9     | 171.9 ± 14.7 *   |
| Protein content in milk, %       | control     | 3.21 ± 0.116     | 3.29 ± 0.108     |
| Yield of milk protein, kg        | control     | 139.4 ± 16.65    | 146.9 ± 15.88    |
| Content of SOMO in milk, %       | control     | 8.66 ± 0.329     | 8.43 ± 0.352     |
| SOMO output, kg                  | control     | 376.1 ± 20.14    | 376.4 ± 23.63    |

The difference is reliable at: * – p<0.05

4. Discussion

An objective analysis of the material obtained is possible taking into account the data accumulated in medical elementology. According to the most widely used hypothesis, the elemental composition of human hair corresponds to the “norm” if its values are in the range of 25–75 percentile (the average value of the content of this chemical element in the population). Values in the range from 10 to 25 and from 75 to 90 percentile are deviations corresponding to the state of "pre-disease". More pronounced deviations from the “norm” should be considered as a disease associated with clinical manifestation of syndromes and symptoms specific for elementoses [10]. This approach can be applied in the analysis of the elemental composition of animal hair, which greatly simplifies the identification and treatment of elementoses.

An initial analysis of the elemental composition of cow wool on the 60th day of feeding with wheat stillage revealed lower exchange pools of chemical elements: calcium, zinc, manganese, selenium. This is due to the violation of mineral metabolism which decreases productivity [11].

Considering that the elemental composition of hair reflects the animal’s mineral nutrition, the excess of the established norms for phosphorus concentration could be a result of the high phosphorus content in the consumed rations of about 181.42–183.97 g/head per day at a daily dose of 53–146 g.

Taking into account the fact that no single element acts in isolation and the degree of its effect on metabolic processes is determined by the intensity of interelement interactions, an increase in the concentration of phosphorus can explain the cause of elementelementosis calcium. Excess phosphorus limits the formation of digestible forms of calcium, and the resulting non-digestible forms are excreted. With prolonged exposure to excess phosphorus, increased mobilization of calcium from the bone depot occurs. It can cause osteodystrophy.

One of the reasons for the increased concentration of lead may be the effect of a lactation period (30–55 days after calving). The milking period is associated with increased mobilization of this element from the bones [12]. Moreover, in some cases, the intake of lead from bones during
pregnancy and lactation can be so significant that it can lead to maternal intoxication [13]. In previous studies, at the initial stage of lactation of Holstein cows, we recorded that lead content exceeded the norm 25–30 times.

The results of the experiment indicate that a four-month correction course using the mineral premix normalized the elemental status indicators for all correctable elements: calcium, zinc, manganese, selenium, lead and strontium. A decrease in the exchange pools of lead and strontium can be considered as a consequence of a significant intake of essential antagonist elements into the body of animals. In the scientific literature, examples of similar interactions of lead and selenium [14], strontium and calcium [15] are described.

It was found that normalization of the elemental status of the missing elements increased the levels of red blood cells and hemoglobin in cows of the experimental group. A possible reason for the revealed pattern is replenishment of zinc deficiency through additional administration of a corrective additive. Zinc is an important factor for erythropoiesis; along with iron and vitamin B12 [16], it can restore the hemoglobin level [17]. The latter may be one of the reasons for the relatively high productivity of cows of the experimental group.

The physiological function of zinc, manganese and selenium [18-20] can be considered as one more possible reason for the increasing volume of milk production during normalization of the levels of missing elements [21-23]. This can be confirmed by an increase in the activity of primary antioxidant defense enzyme by 6.6 % (p <0.05), which was recorded against a background of a decrease in the level of molon dialdehyde by 21.24 % (p <0.05).

5. Conclusion
The use of fresh wheat stillage in feeding dairy cows is associated with the development of hypoelementoses for calcium, selenium, zinc and manganese, which is observed in the chemical composition of the wool. Normalization of the elemental status through the introduction of missing elements increases the volume of milk production.

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References
[1] Donat K, Siebert W, Menzer E and Söllner-Donat S 2016 Long-term trends in the metabolic profile test results in German Holstein dairy herds in Thuringia, Germany Tierarztl. Prax. Ausg. G Grosstiere Nutztiere 44(2) 73–82 DOI: 10.15653/TPG-150948
[2] Pavlata L, Chomat M, Pechova A et al 2011 Impact of long-term supplementation of zinc and selenium on their content in blood and hair in goats Vet. Med. 56(2) 63–74
[3] Zhao X J, Wang X Y, Wang J H et al 2015 Oxidative stress and imbalance of mineral metabolism contribute to lameness in dairy cows Biol. Trace Elem. Res. 164(1) 43–9 DOI: 10.1007/s12011-014-0207-1
[4] Skalny A V, Skalnaya M G, Tinkov A A et al 2015 Hair concentration of essential trace elements in adult nonexposed Russian population Environ. Monit. Assess. 187(11) 677 DOI: 10.1007/s10661-015-4903-x
[5] Miroshnikov S, Kharlamov A, Zavyalov O et al 2015 Method of sampling beef cattle hair for assessment of elemental profile Pakistan J. of Nutrit. 14(9) 632–6
[6] Miroshnikov S A, Zavyalov O A., Frolov A N et al 2017 The reference intervals of hair trace element content in hereford cows and heifers (Bos taurus) Biol. Trace Elem. Res. 180(1) 56–62 DOI: 10.1007/s12011-017-0991-5
[7] Miroshnikov S A, Skalny A V, Zavyalov O A et al 2020 The Reference Values of Hair Content of Trace Elements in Dairy Cows of Holstein Breed Biol. Trace Elem. Res. 194(1) 145–51
[8] Miroshnikov S, Zavyalov O, Frolov A et al 2019 The content of toxic elements in hair of dairy cows as an indicator of productivity and elemental status of animals Environ. Sci. and Pollut. Res. 26(18) 18554–64

[9] Kossaibati M A and Esslemont R J 1997 The costs of production diseases in dairy herds in England Vet. J. 154 41–51 DOI: 10.1016/S1090-0233(05)80007-3

[10] Skalnaya M G, Demidov V A and Skalny A V 2003 About the limits of physiological (normal) of Ca, Mg, P, Fe, Zn and Cu in human hair Trace elem. in med. 4(2) 5–10

[11] Skalny A V 2003 The reference values of the concentration of chemical elements in hair obtained by ICP-AES Trace Elem. in Med. 4(1) 55–6

[12] Ushakov A S and Rakhmatullin Sh G 2016 Influence of microelements (I, Co, Cu) on metabolism of Black Spotted bulls during fattening on distiller's grains Vest. of beef cattle breed. 4 98–107

[13] Maldonado-Vega M, Cerbón-Solorzano J, Albores-Medina A et al 1996 Lead: intestinal absorption and bone mobilization during lactation Hum. Exp Toxicol. 15(11) 872–7

[14] Bellinger D, Leviton A, Watermeaux C, Needleman H L and Rabinowitz M 1987 Longitudinal analyses of prenatal and postnatal lead exposure and early cognitive development N. Engl. J. Med. 316 1037–43

[15] López Alonso M, Prieto Montaña F, Miranda M et al 2004 Interactions between toxic (As, Cd, Hg and Pb) and nutritional essential (Ca, Co, Cr, Cu, Fe, Mn, Mo, Ni, Se, Zn) elements in the tissues of cattle from NW Spain Biometals 17(4) 389–97

[16] Miller E K, Blum J D and Friedland A J 1993 Determination of soil exchangeable-cation loss and weathering rates using Sr isotopes Nature 362 438–41

[17] Hayden S J, Albert T J, Watkins T R and Swenson E R 2012 Anemia in critical illness: Insights into etiology, consequences, and management Am. J. Respir. Crit. Care Med. 185 1049–1057. doi: 10.1164/rccm.201110-1915CI.

[18] Alarcon K, Kolsteren P W, Prada A M et al 2004 Effects of separate delivery of zinc or zinc and vitamin A on hemoglobin response, growth, and diarrhea in young Peruvian children receiving iron therapy for anemia J. Am. Clin. Nutr. 80 1276–82 DOI: 10.1093/ajcn/80.5.1276.

[19] Michalska-Mosiej M, Socha K, Soroczyńska J et al 2016 Selenium, Zinc, Copper, and Total Antioxidant Status in the Serum of Patients with Chronic Tonsillitis Biol. Trace Elem. Res. 173(1) 30–4 DOI: 10.1007/s12011-016-0634-2

[20] Duskaev G, Karimov I, Levakhin G et al 2019 Ecology of ruminal microorganisms under the influence of Quercus Cortex extract International Journal of GEOMATE 16(55) 59-66

[21] Karimov I, Duskaev G, Inchagova K, et al 2017 Inhibition of bacterial quorum sensing by the ruminal fluid of cattle International Journal of GEOMATE 13(40) 88-92

[22] Kvan O, Duskaev G, Rakhatmatullin S et al 2019 Changes in the content of chemical elements in the muscle tissue of broilers on the background of plant extract and tetracyclines International Journal of Environmental Science and Development 10(12) 419-423