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Influence of chelations on dairy productivity of cows in different periods of manufacturing cycle

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The research has established the positive effect of the organic form of mixed ligand complexes Cu, Zn and Mn on the milk productivity of high-producting cows of Holstein breed. It was proved that cows of the second experimental group which consumed mixed ligand complexes Cu, Zn and Mn in composition of fodder in the amount of 100% by concentration of metal had the highest dairy productivity in the period of milking. According to the indicator of the natural fat milk yield the advantage was 12% ($p \leq 0.01$), but fat milk 8.5%. In recalculation of milk yield of fat 4% advantage was 21.3% ($p \leq 0.,001$). By the level of protein in milk experimental cows had an advantage 3.4%.

In the main period of experiment the gross natural milk yield per cow increased by 10.9%, fat content on 0.11%, indicator of milk yield of basic fat on 14.2% ($p \leq 0.001$), it was due to changing sulfates Mn, Cu and Zn on mixed ligand complexes Mn, Cu and Zn, and these elements have a better assimilability. According to the results of the experimental study, the duration of the service-period of cows in the experimental group was 44 days shorter than in the control, and 22.6% lower in the index of insemination.

Keywords: High-producting cows; ration; premix; trace elements; sulfates; mixed ligand complexes; Cu; Zn; Mn; milk productivity; milk fat; milk protein; index of insemination

Introduction

The most important task of dairy cattle breeding is to provide the population with ecologically pure dairy products. To solve this problem high-productivity herds in particular of black-and-white patched Holstein breed cows were created in many farms in Ukraine including the Dnipropetrovsk region where the milk yield per cow reaches 10-12 thousand kg of milk for lactation (Havturina et al., 2014, 2015).

Previous studies found that the full value of feeding high-producting cows is associated with the implementation of their genetic potential of milk productivity, first of all, it is necessary to determine the impact on the indicators of dairy productivity (Bomko et al.,2017).

Lack of trace elements in soils, feed, and rations of animals is observed in all zones of Ukraine. This leads to a metabolic disorders in the animal body, reduces productivity, product quality, immunity; a number of different diseases appears. Various premixes are added to rations to balance the mineral nutrition; however, the using of a single standard premix recipe throughout the country is impossible because it does not fully satisfy the need of animals in each element (Bomko et al.,2017; Horchanok et al., 2018).

The content of trace elements in the body of animals, in their products is affected by feeds that animals consumed. Most of the functions in an animal's organism are carried out in parallel or in groups, affecting the body as a whole or on certain processes in it, some of them are antagonists (Goldman, 2009; Bomko et al., 2015).

Sometimes individual elements can replace each other in the formation of organic-mineral compounds, which can be detected in some enzymes. Microelements Cuprum, Zinc and Manganum are important elements of the superoxide dismutase enzyme. They play a decisive role in the antioxidant protection of the animal's body by improving their reproducible function, maintaining health (Pechová et al., 2008; Sarah, 2011).

When rationing trace elements it is necessary to consider that each of them plays a role in the vital functions of animals, and there is a close connection between them which should be taken into account when creating new mineral feed additives (Somkuwar et al., 2011).

In the majority of premixes, inorganic forms of trace elements are used in the forms of chlorides, sulfates and oxides, which are poorly digested and used by animals because animals are naturally adapted to assimilate organic chelation forms of minerals

from plant fodder (Smetanina et al., 2017). Inorganic salts of trace elements in composition of mixed fodders are not always safe for animal health and have low bioavailability. Also low digestibility of trace elements from chlorides, sulfates and oxides increases the risk of environmental pollution of heavy metals because they are excreted from the body in a greater degree than absorbed by it (Miller, 2012; Havturina et al., 2015).

In the scientific and economic research we investigated the influence different levels of mixed ligand complex of Cobalt on milk productivity and its exchange in the organism of highly productive cows of Ukrainian Black-and-White milk breed in combination with sulfates: Zinc 650 g/t, potassium 38 g/t, sodium selenite 1.8 g/t. The conducted researches have proved that the highest average daily milk yield of natural fat had cows, which consumed mixed fodder in the composition of mixed ligand complex of Cobalt in the amount of 75% by concentration of the metal, which prevailed the analogues of the control group for this indicator, respectively, by 4.4 kg ($p \leq 0.01$), or by 9.7% (Smetanina et al., 2017).

Previous studies on the bioavailability of chelates have shown that great biologic accessibility is a characteristic of the microelements of organic forms, especially the chelations of microelements with amino acids. Therefore, one of the means to improve the using of microelements by an animal organism is to increase the applying of organic minerals in cattle breeding such as bioplexes and mixed ligand complexes of trace elements (Bomko et al., 2015; Horchanok et al., 2018).

Experimental studies of substantiating recipes for improved zonal premixes for the highest-producting Holstein breeds with the using of mineral additives of organic form of mixed ligand complexes Cu, Zn and Mn, comprehensive studies of their impact on productivity, metabolism, product quality and economic efficiency of use have an important scientific and economic significance today and are actual to each biogeochemical zone of Ukraine (Bomko et al., 2015). So, the purpose of the study was to establish the advisability of using various forms and sources of Zinc, Cuprum and Manganum in the diets of the highest-producting Holstein cows, taking into account their physiological state and productivity.

Materials and methods

Production research was conducted in the conditions of the private limited company "Agrofirma named after Horkii" in Dnipropetrovsk region. For this purpose 100 analogical cows were taken in 1-2 months of lactation; they were divided into two groups of 50 heads in each. One group was control, and the other one was experimental (Table 1).

Table 1. Scheme of production research.

Groups	Livestock	Researched factor
1 control	50	Fodder concentrate+$MnSO_4$-227 g/t; $CuSO_4$-21.2 g/t; $ZnSO_4$-292 g/t
2 experimental	50	Fodder concentrate and mixed ligand complexes: Zinc 363 g/t; Cuprum 40 g/t; Manganum 313 g/t

Feeding of experimental cows was carried out with the same hay-silage-root-and-concentrated rations. Chemical composition and nutrition of rations were determined according to the methodology (Petukhova et al., 2010).Rations differed only in content in the premix of mineral compounds. Cows of the control group consumed feed added with sulfates Mn, Cu and Zn, and cows of the experimental group - added with mixed ligand complexes Mn, Cu and Zn, which showed high indexes according to the results of previous scientific and economic experiments.

During the production experiment such factors were accounted in the groups of cows: the actual consumption of feed, daily milk yield, fat content, protein in milk, dynamics of live weight, duration of the service period, index of insemination, feed costs per 1 kg of milk. Determination of the live weight of experimental cows was realized on monthly individual weightings, which were carried out in 1-2 hours before morning feeding. For the initial and final live weight of the cows the absolute gain of live weight was determined. Insemination of cows in groups was carried out by the sperm of one bull-bearer. The duration of the service period and the insemination index were also taken into account. The milk yield of the experimental cows was determined daily for each group and individually from each cow during the ten-day control milking. The cows were monitored for mastitis by a daily clinical examination of their mammary glands. Selection of milk samples for analysis was carried out in accordance with the generally accepted methodology (Kozyr et al.,2002).

The biometric processing of the results was carried out on PC with help of software MS Excel with using of inbuilt statistical functions. The probability of the difference between indicators was assessed according to Student'st-test (Melnichenko et al., 2006).

Results and discussion

Studying of changes in milk productivity and the efficiency of organic feeding of mixed ligand complexes Mn, Cu and Zn in the composition of premixes of ration of experimental cows showed that during the preparatory period the live mass of cows was similar, the difference was only 0.5%, but for milk yield, and milk fat content of analogues did not differ (Table 2).

In the first 100 days of lactation cows of the experimental group significantly differed in the indicator of the natural fat milk yield, it was 45.7 kg versus 40.8 kg or 12% ($p \leq 0.01$), and the fat content of milk from the cows of the experimental group was 4.09% versus 3.77%.

Table 2. Productivity of experimental cows.

Index	Group

	Control	Experimental
Daily milk yield in the preparatory period, kg		
The live weight of cows, kg	623.5 ± 4.45	627.2 ± 5.48
Milk of natural fat	36.4 ± 0.38	36.3 ± 0.40
Fat content in milk, %	3.84 ± 0.012	3.86 ± 0.013
Daily milky yield in 70 days of the experiment, kg		
Milk of natural fat	40.8 ± 0.38	45.7 ± 0.32**
Milk of 4% fat	38.5 ± 0.39	46.7 ± 0.41***
Fat content in milk, %	3.77 ± 0.021	4.09 ± 0.021
Protein content in milk, %	3.28 ± 0.023	3.39 ± 0.009
Duration of service period, days	119	75
Insemination index	1.68	1.3

In recalculation of milk of 4% fat content the preference for milk yield was 8.2 kg or 21.3% ($p \leq 0.001$). By the level of protein in milk experimental cows also had a higher rate which was 3.39% versus 3.28%. The duration of the cows service-period in the 2nd experimental group decreased significantly and amounted to 75 days and the index of insemination was 1.3. The cows of the experimental group over the next 100 days of lactation had an advantage over analogues in control group by indexes of quantitative and qualitative indicators of milk.

For the period of research (170 days) gross natural milk yield per one cow increased on 597 kg or on 10.9%. In the milk of experimental cows an increase in the fat content was on 0.11%, and by the indicator of the milk yield of the base fat the advantage was on 835 kg, or 14.2% ($p \leq 0.001$) (Figure 1).

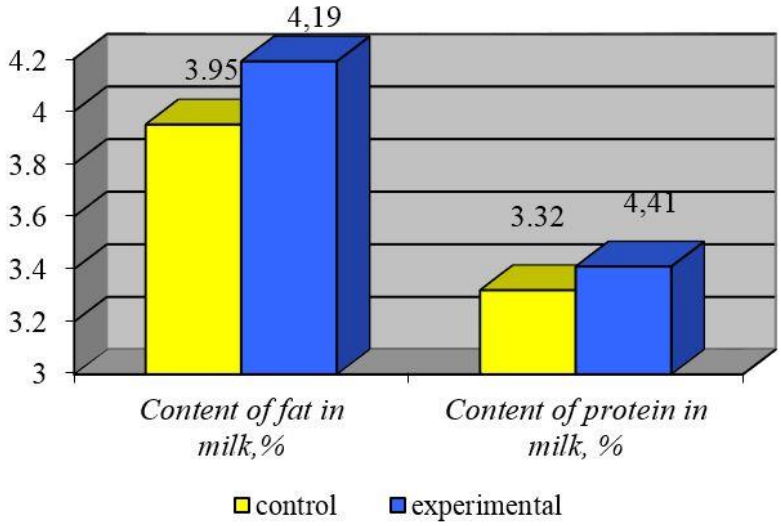

Figure 1. Qualitative indicators of milk.

The change of sulfates Mn, Cu and Zn on mixed ligand complexes Mn, Cu and Zn significantly influenced on the reproductive ability of cows. As it was figured out, the cows of the experimental group had the service period 44 days shorter than in the control one, and the insemination index was 0.38 or 22.6% less than in the other group. Milk productivity and reproductive ability of cows greatly depend on the preservation of live weight of animals. During the production experiment it was founded out that in experimental group cows lost live weight at the beginning of the experiment period, which coincided with the beginning of lactation, twice less than in control group (7.1 versus 25.4 kg).

Consequently, the results of the production experiment confirmed the data of scientific studies of other scientists, namely: an increase of the average daily milk yield of cows compared with the control on 3.52 kg, or 10.9%; insemination index - 0.38; reduction of the cows service period for 44 days. The given examples are the reason to formulate valid conclusions and proposals about using of trace elements of organic origin in rations of lactation cows at different periods of the manufacturing cycle.

Conclusions

Adding of mixed ligand complexes of Cuprum, Zinc and Manganum in fodder concentrates for Holstein cows contributes to receiving 10.9% more milk of natural fat in 170 lactation days in comparison with control analogues.The obtained results broad and deep the modern understanding of the metabolic and productive effects of mixed ligand complexes of Cuprum, Zinc and Manganum in the body of the highest-producting cows because low digestibility of trace elements from chlorides, sulfates and oxides increases the risk of contamination of the environment with heavy metals, they are excreted from the body in a greater degree than absorbed by it.

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