

Use of Adsorbent Preparations to Detoxify Heavy Metals in Fattening Young Cattle

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Abstract:

Now, the requirements for the ecological and nutritional qualities of beef increase. It is especially important to achieve the reduction of toxicants in industrially intensified regions. The territory of the Republic of North Ossetia – Alania is among the most polluted with heavy metals regions of Russia. **The research aims** to study the effectiveness of using chelaton and toxi-nyl dry in diets of fattening bulls to increase the economic and biological indicators when detoxifying heavy metals.

Research methods. The objects of research were the bulls of Simmental breed, which by analogue scale were divided into 4 groups of 10 animals each. The results were statistically processed by Student's t-test using mathematical analysis software package "Microsoft Excel".

Research results. To detoxify heavy metals in the diets of fattening bulls, adsorbents toxi-nyl dry and chelaton were used. The most productive and the biological effect provided combined use of these specified drugs that have sorptive properties. When feeding the mixture of preparations animals in the third test group had an increase in the average daily gain in live weight and a decrease in feed consumption per unit of production. When combined feeding these preparations bulls of the third test group underwent the optimization of metabolic processes in the rumen activating proteases, cellulase and amylase in the proventriculus content. In the rumen fluid of animals of this group there was an increase in the number of infusoria, the number of volatile fatty acids and propionic acid. When feeding preparations toxi-nyl dry and chelaton animals of the third test group versus the control underwent enriching their blood with erythrocytes, hemoglobin, crude protein, glucose, calcium and phosphorus. At this, by the end of the experiment, the combined use of the tested preparations allowed versus the control to reduce the concentration of zinc, cadmium and lead in the bulls' blood of the third test group.

Keywords: fattening bulls, heavy metals, adsorbents, live weight gain, rumen digestion, morphological and biochemical blood indexes.

The relevance of the topic. Productivity, physico-chemical and technological properties of meat products and metabolic processes in bodies of young cattle are significantly affected by chemical pollutants. Among numerous pollutants heavy metals take special place. Their toxic effect is due to the fact that they form insoluble compounds with proteins, changing properties and inactivating a number of vital enzymes [1, 2].

The territory of North Ossetia – Alania is among the most polluted with heavy metals regions of the Russian Federation due to the high concentration of industrial enterprises of nonferrous metallurgy in the city of Vladikavkaz (JSC "Magnet", public JSC "Electrozink", JSC "Pobedit" and others [3, 4].

Now, new generation adsorbent preparations are widely used to detoxify heavy metals when young cattle fattening [5, 6, 7]

The research aims to study the effectiveness of using chelaton and toxi-nyl dry in the diet of fattening bulls to increase the economic and biological indicators when detoxifying heavy metals.

RESEARCH METHODS.

To study the effect of the tested feed additives on economic and biological indicators of fattening bulls, the scientific-production experiment was conducted in the conditions of LLC "Iraf-Agro", Irafsky district of North Ossetia – Alania. 40 Simmental bulls of 6 month old were selected and then divided by the analogue scale into 4 groups of 10 animals each.

The experiment was carried out in accordance with the experiment scheme shown in table 1.

The experiment lasted 12 months. In the course of studies bulls of (control) group were fed the basic diet (BD) but animals in the 1, 2 and 3 test groups in addition to BD consumed adsorbents toxi-nyl dry at a dose of 1,0 kg/t mixed feed, chelaton at a dose of 1,0 g/100 kg live weight and a mixture of these

preparations in the specified dose.

The research results were statistically processed by Student's t-test using the package for the mathematical analysis of software "Microsoft Excel".

RESEARCH RESULTS.

In the course of the experiment, the heavy metal content in daily diets of the test bulls depending on their age was studied. In feeding diets of the experimental young cattle there was the excess in MPC of zinc respectively: at the age of 6-9 months - 2,01 times; 9-12 months - 2,14 times; 12-15 months - 2,17 times and 15-18 months - 2,21 times. In these age periods the diets of the test bulls showed lead in amount of 160,5; 180,1; 196,9 and 204,1 mg and cadmium – 10,31; 10,42; 11,04 and 12,20 mg, respectively.

The excess content of zinc, lead and cadmium in feed has as impact on growth power of young ruminants and feed conversion into products. According to the results of check weighing, the absolute and average daily gain of live weight and power consumption, as well as digestible protein per 1 kg of bulls gain in the compared groups are calculated (table 2).

The results of the experiment showed that in the conditions of excess heavy metal content in the feed bulls of the third test group differed in the highest growth intensity, which at the age of 18 months had significantly 6,03% (P<0,05) more removing body weight compared to the animals of the control group.

The highest growth power characterized animals of the third test group, which compared to the counterparts in the control group had significantly 10,05% (P<0,05) higher indicators of absolute and average daily gain. According to these indicators animals of the first and second test groups took an intermediate position between the counterparts of the control and third test groups.

Table 1- The scientific experiment scheme

n = 10

Group	Basic diet (BD) with increased content of Zn, Pb and Cd	Doses of preparations	
		Toxic-nyl dry,kg/t of mixed feed	chelaton,g/100kg of live weight
Control	BD	-	-
1 test	BD	1,0	-
2 test	BD	-	1,0
3 test	BD	1,0	1,0

Table 2 – Live weight gain and power consumption and digestible protein per 1 kg of experimental animals' gain for an experiment
n = 10

Indicator	Groups			
	control	1 test	2 test	3 test
Live weight, kg:				
at the beginning of the experiment	169,6±0,38	169,8±0,38	169,5±0,39	169,7±0,42
at the end of the experiment	422,3±3,11	436,7±2,98	437,1±3,33	447,8±3,16
Live weight gain:				
absolute, kg	252,7±3,05	266,9±2,85	267,6±3,16	278,1±3,10
average daily, g	692,33±14,4	731,23±15,0	733,15±14,2	761,92±16,0
In to the control	100,00	105,62	105,90	110,05
Consumption per 1 kg gain:				
Energetic feed unit	7,96	7,53	7,50	7,21
in % to the control	100,00	94,60	94,22	90,58
digestible protein, g	740,66	700,72	699,40	673,33
in % to the control	100,00	94,61	94,43	90,91

When fattening young cattle in the conditions of violating the nutritional ecology the essential role should be given to the efficiency of using energy and feed nutrients. On this basis, it was found that the best feed payment in products had animals of the third test group, which versus the control consumed per 1 kg gain 9,42% less energetic feed units and 9,09% less digestible protein.

According to the results of the chemical analysis of feed and feed residues, the coefficients of nutrients digestibility in young fattening cattle diets were determined.

However, combined feeding the preparations chelaton and toxi-nyl dry in diets with high content of zinc, lead and cadmium contributed to intensify the hydrolysis of protein, fiber and soluble carbohydrates in feed. Thereby, the bulls in the third test group surpassed significantly ($P<0,05$) their control counterparts in crude protein, fiber and nitrogen-free extractives digestibility coefficients by 3,8, 3,3 and 3,9% respectively.

This shows that animals of the third test group during applying the mixture of the tested feed preparations had increasing in proteolytic, cellulolytic and amylolytic enzymes of

the gastrointestinal tract, as evidenced by the research results of the proventriculus content of animals in the control and the best in productivity third test group (table. 3).

It was found no significant differences in the pH value and ammonia concentration in the rumen content between animals of the compared groups.

When using the mixture of preparations chelaton and toxi-nyl dry in proventriculus of animals from the third test group processes of hydrolysis of feed protein, fiber and soluble carbohydrates were catalyzed, which is consistent with the crude protein, fiber and nitrogen-free extractives digestibility coefficients. Moreover, the differences between the bulls of the third test and control groups were significant ($P<0,05$) in proteolytic activity by 3,87%, cellulolytic – 3,66% and amylolytic – 4,39 ml starch. The increase in proteolytic, cellulolytic and amylolytic activity of rumen fluid versus the control counterparts was accompanied by the significant ($P<0,05$) increase in the number of infusoria by 214 thousand / ml in proventriculus of young cattle from the third test group.

Table 3 – Enzymatic activity and the number of infusoria in the rumen fluid

n = 3

Indicator	Group	
	control	3 test
pH medium	7,02±0,05	7,10±0,02
Ammonia, mg%	18,69±0,33	18,73±0,48
Infusoria, thousand/ml	481±4,78	695±6,03
Activity: amylase, mg starch	20,61±0,32	25,00±0,41
cellulase,%	15,78±0,27	19,44±0,36
proteinase, %	43,44±0,34	47,31±0,40
VFAs, mmol/100 ml	8,44±0,29	9,77±0,32
VFAs molar ratio, %:		
acetic	63,31±0,36	63,60±0,49
propionic	21,24±0,28	24,54±0,32
butyric	13,44±0,31	10,44±0,35

Table 4-Dynamics of biochemical indicators in animals' blood serum

n = 3

Indicator	Group			
	control	1 test	2 test	3 test
Sugar, mmol/l	3,44±0,05	3,78±0,04	3,80±0,06	3,93±0,03
Crude protein, g/l	74,45±0,65	77,88±0,58	78,00±0,70	79,23±0,80
Calcium, mmol/l	2,81±0,12	3,12±0,14	3,19 ±0,17	3,34±0,18
Phosphorus, mmol/l	1,71±0,07	2,04±0,08	2,08± 0,09	2,18±0,08
Zinc (MPC=22), µg/kg	38,55±0,28	20,06±0,34	20,22±0,29	15,98±0,44
Cadmium (MPC=0,05), µg/kg	0,135±0,002	0,069±0,004	0,061±0,002	0,046±0,003
Lead (MPC=1,2), mg/kg	2,34±0,03	1,50±0,04	1,44±0,04	0,90±0,05

In the course of the experiment, combined using the preparations chelaton and toxic-nyl dry provided in proventriculus high intensity of simple and complex sugars hydrolysis, which contributed to significantly 1,26 mmol/ml ($P<0,05$) more volatile fatty acids in rumen fluid of animals in the third test group than in control one. Moreover, the mixture of these feed additives provided for animals in the third test group relative to the control significant ($P<0,05$) increase in the concentration of propionic acid by 4,3%.

By the end of fattening application of the mixture of preparations chelaton and toxi-nyl dry contributed to the trend of insignificant ($P>0,05$) increase in these indicators in the blood of animals from test groups. In the greatest concentration of red blood cells and hemoglobin differed the blood of bulls in the third test group that have surpassed their control counterparts in these indicators, respectively, by $0,48 \times 10^{12}/l$ and 5,9 g/l. However, they were within normal physiological parameters.

Feeding preparations of adsorbents with age had the most significant effect on the biochemical composition of bulls' blood serum in the test groups (table. 4).

The highest level of sugar in the blood had young of the third test group – 3,93 mmol/l, which is 0,49 mmol/l ($P<0,05$) more than in the control. This testifies to the activation of carbohydrate metabolism in calves of the test groups, because under the adsorbents influence less toxicants were absorbed into their blood from the gut. In addition, the content of crude protein increased in the blood serum of bulls from the test groups. So, at the end of the experiment the best result on this indicator had counterparts of the third test group, having surpassed the control on the serum protein availability significantly ($P<0,05$) by 4,78 g/l.

It is known that the ratio of calcium and phosphorus in the animals' blood is dependent not only on their quantity but also the elements ratio in the fed diet. The use of the tested feed additives had a positive effect on the mineral metabolism in bodies of young fattening cattle of the test groups, as evidenced by the data of calcium and phosphorus content in the blood serum. Moreover, versus the control counterparts bulls in the third test group contained respectively 0,53 ($P<0,05$) and 0,47 mmol/l

($P<0,05$) more of these macroelements in their blood serum.

The studies found that both preparations had high detoxifying properties. At the same time, by the end of the experiment, the combined use of the tested preparations allowed versus the control to significantly ($P<0,05$) reduce the concentration of zinc by 2,41 times, cadmium – by 2,93 and lead – by 2,60 times in the blood of bulls from the third test group. At this, in any case there was no an excess in the maximum permissible concentration of these elements.

CONCLUSION.

Inclusion into the fattening young cattle diet with the increased background of heavy metals the mixture of preparations toxi-nyl dry at a dose of 1,0 kg/t feed and chelaton in the amount of 1,0 g/100 kg of live weight contributed to the improvement of rumen digestion and intermediate metabolism, as well as the increase in live weight while reducing feed consumption per unit of production.

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