

Effect of adsorbent and enzyme preparations on productivity of fattening steers with diets containing heavy metals

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Abstract

The territory of the Republic of North Ossetia – Alania is one of the most heavy metal contaminated regions in the Russian Federation, due to the number of large non-ferrous metallurgy enterprises in Vladikavkaz. The research is aimed at studying the effect of enzyme preparation Celloviridin G20x and adsorbent Toxfin supplements in the fattening steers' diets containing an increased heavy metal level on their bio-productive indicators. During the experiment, 40 six month-old Simmental steers were selected, which by the analogue scale were divided into 4 groups of 10 heads each. The experiment lasted 12 months. The resulting digital material was processed statistically using the Excel information program. The research results showed that the best productive and physiological effect was obtained when joint feeding these feed additives. Thus, when joint feeding preparations Celloviridin G20x at a dose of 70 g/t and Toxfin at a dose of 1 kg/t mixed feed, the third test group had a significant increase in the average daily live weight gain and the energy and digestible protein to product conversion. When joint feeding these preparations as part of the diet with an increased content of zinc, lead and cadmium, there was an increase in the breakdown of feeds protein, cellulose and easily soluble carbohydrates. Due to this, the animals of the third test group significantly ($P<0.05$) exceeded their control counterparts in the digestibility coefficients of dry matter, organic matter, crude protein, crude fiber, and nitrogen free extractives. In the process of heavy metal detox by joint feeding preparations Celloviridin G20x and Toxfin the counterparts in the third test group vs. the control for a day deposited more nitrogen in the body.

Keywords: bulls; heavy metals; dietary supplements; detoxification; gain; digestibility.

Introduction

It is known that the physical and chemical properties of young cattle meat are significantly affected by chemical toxicants. Among them, heavy metal salts have a special place. They have a high biological activity and accumulating in the body, negatively affect the metabolism. The toxic effect of these toxicants is due to the fact that they inactivate a number of vital enzymes (Temiraev et al., 2015; Dzodziewa et al., 2015; Tsalieva et al., 2017; Temiraev et al., 2017; Yuldashbaev et al., 2020).

The territory of the RNO – Alania belongs to the most heavy metal contaminated regions in Russia due to the high concentration of non-ferrous metallurgy enterprises in the city of Vladikavkaz, such as JSC «Electrozinc», JSC «Pobedit», etc. Along with, the steers' feeding conditions affect the development and ratio of plastic material in their body, the yield and quality of meat (Temiraev et al., 2011; Biswas et al., 2010; Temiraev et al., 2012; Kokaeva et al., 2017; Temiraev et al., 2020). High detoxification effect is reported when introducing adsorbents in combination with biologically active additives (vitamins, antioxidants and enzyme preparations) into the fattening steers' diets, which contributes to improve the beef nutritional value and environmental safety (Temiraev et al., 2012; Tedtova et al., 2017; Yarmots et al., 2013; Vityuk et al., 2017; Kokaeva et al., 2020).

The present research is aimed at studying the effect of enzyme preparation Celloviridin G20x and adsorbent Toxfin supplements in the fattening steers' diets containing an increased heavy metal level on their bio-productive indicators (Khamikoeva et al., 2018).

Material and methods

The scientific experimentation according to the scheme shown in table 1 and conducted in the conditions of the agricultural production cooperative «Vesna» in the Republic of North Ossetia–Alania was focused on implementation of specified research tasks. For this purpose, 40 six month-old Simmental steers were selected, which by the analogue scale were divided into 4 groups of 10 heads each. The experiment lasted 12 months.

The dynamics of the steers' live weight was monitored based on the results of monthly control weighing. According to their data, the absolute and average daily body weight gain of test steers was calculated.

Celloviridin G20X. Manufacturer. Berdsk plant of biological preparations, Russia. Composition and form of release. The preparation is obtained by drying in a spray dryer the filtrate obtained by submerged cultivation of the fungus *Trichoderma reesei* (viride). Fine, hygroscopic, amorphous powder from light yellow to dark brown, containing a complex of enzymes capable of hydrolyzing plant polysaccharides – cellulases, glucanases, xylanases, hemicellulases and others.

Toxfin is a new generation adsorbent manufactured by Kemin Europa N.V. (Belgium). It is a dry powder of beige-greenish color, intended for the adsorption of mycotoxins in grain and mixed fodder for farm animals and poultry. Toxfin contains in its composition: binders hydroaluminosilicate – bentonite within 48.9-50.9%, sepiolite – within 39.0-41.0%, steatites – up to 0.2-0.6%, silicon oxide – up to 0.3-0.7%; preservatives – calcium propionate – up to 4.0-5.0%, sorbic acid – up to 0.05-0.15%, fumaric acid – up to 0.2-0.4%; antioxidant – butylhydroxyanisole - up to 0.05-0.15% and the carrier – table salt – up to 3.7-4.7%. The sorption capacity of this drug is at least 95%. The diet of the test animals is shown in table 2.

According to the chemical analysis results, it was found that the diets of the test animals exceeded the maximum permissible concentration for zinc: 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. During these age periods, the diets of the test steers were found to contain lead in the 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 enzyme preparation and adsorbent were added to the mixed feed using industrial dispensers by three-stage mixing.

The physiological exchange experiment was carried out according to the generally accepted method (Ovsyannikov) using animals of two groups: control and the third test (the best productive) groups. To do this, three heads were selected from each group, which were housed tethered in individual stalls with the sloping floor covered with the rubber mat. During 7 days, three times a day, 100 g of each head's feces and urine were collected, weighed, and taken average samples. Based on the results of the chemical analysis of feed, feces and urine samples, the digestibility and accessibility of diet nutrients were calculated.

The content of heavy metals in the feed samples was determined by the atomic adsorption method on an AAZ-115-M1 spectrophotometer in the laboratory of aerocology of the Gorsky State Agrarian University (Russia). The resulting data was processed statistically using by Student's criterion in the the Excel information program

Table 1 – Scheme of scientific experimentation (n= 10)

Group	Basic diet (BD) with a high content of Zn, Pb and Cd	Doses of preparations supplementation	
		Celloviridin G20x, g/t mixed feed	Toxfin, g/t mixed feed
control	BD	-	-
1 test	BD	70	-
2 test	BD	-	1,0
3 test	BD	70	1.0

Table 2 – Daily diet for steers aged 9-12 months

Indicator	Required rate	Indeed contains
Feed (kg) and additives:		
Sudan grass hay	-	2
Corn silage + sorghum	-	10
Dry pulp	-	0.9
Mixed feed	-	2.85
Feed molasses	-	0.8
Table salt, g	35	28
The diet contains:		
EFU	5.30	5.33
Dry matter, kg	70.0	69.8
Exchange energy, MJ	53.0	53.30
Crude protein, g	1175	1200
Digestible protein, g	765	778.7
Crude fiber, g	1990	2008
Starch, g	1215	1202
Sugar, g	810	806
Crude fat, g	310	298
Calcium, g	54	56.1
Phosphorus, g	29	30
Magnesium, g	20	19.8
Potassium, g	69	67.8
Sulfur, g	27	26.5
Iron, mg	600	1804
Copper, mg	85	83
Zinc, mg	450	855.48
Lead, mg	-	264
Cadmium, mg	-	18.18
Cobalt, mg	6	5.93
Manganese, mg	400	397
Iodine, mg	3	3.03
Carotene, mg	210	231
Vitamin D, thou. IU	4.3	4.5
Vitamin E, mg	330	341

Results and discussion

The excessive content of heavy metal salts in the diet affects the young animals' growth rate and feed conversion. Therefore, according to the results of the control weighing, the growth rate, energy consumption and digestible protein per 1 kg of steers' gain in the compared groups were determined (table 3).

It was found that at the age of 18 months, the highest growth energy characterized animals in the third test group, which relative to the control had a significantly ($P < 0.05$) 6.03% greater final live weight, so that the steers of this group vs. the control were characterized by higher absolute and average daily gain by 10.05% ($P < 0.05$). Along with this, the best feed-conversion efficiency characterized animals in the third test group, which per 1 kg gain consumed vs. the control 9.42% of EFU and 9.09% less of digestible protein. Our data are consistent with the data obtained by a number of authors (Dzodzieva et al., 2015; Kokaeva et al., 2017).

At the age of 15 months, the exchange experiment was conducted using animals of the control and best productive third test groups, for which purpose three heads were selected from each group. According to the results of the chemical analysis of feeds and their residues, the nutrient digestibility coefficients of test animals' diets were calculated (table 4).

Analysis of the data from the exchange experiment shows that there were no significant ($P > 0.05$) differences in the level of crude fat digestibility between steers of the control and the third test groups.

At the same time, when joint feeding the enzyme preparation Celloviridin G20x and adsorbent Toxin as part of diets with the increased content of zinc, lead and cadmium, there was an increase in the breakdown of feeds protein, cellulose and easily soluble carbohydrates (nitrogen-free extractives). Due to this, the animals of the third test group significantly ($P < 0.05$) exceeded their control counterparts in the digestibility coefficients of dry matter by 2.90%, organic matter – by 3.11%, crude protein – by 2.89%, crude cellulose – by 2.31% and nitrogen-free extractives – by 3.88%, respectively.

This indicates that using the test feed additives activated in animals of the third test group proteolytic,

cellulolytic and amylolytic enzymes in their rumen microflora, that is, improving the digestibility of dry and organic matter during heavy metal detox indicates with the help of these adsorbents the optimization of digestive metabolic processes in test young animals by activating the fermentolysis of feeds protein, cellulose and starchy substances. Our data are consistent with the data obtained by a number of authors (Kokaeva et al., 2017; Yuldashbaev et al., 2020).

It is known that increasing digestibility of the diet protein does not always simultaneously increase its accessibility, as various toxicants in feeds may activate the deamination process, which increases the amount of nitrogen excreted with animals' urine. Table 5 shows the nitrogen balance in test animals.

Table 3 – Productivity and nutrients consumption per 1 kg of test animals' gain (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 control	100.00	105.62	105.90	110,05
Consumed per 1kg live weight gain, kg:				
EFU	7.96	7.53	7.50	7.21
digestible protein, g	740.66	700.72	699.40	673.33

Table 4 – Nutrients digestibility coefficients of diets, % (n = 3)

Indicator	Group	
	control	3 test
Dry matter	68.41 ± 0.37	71.31 ± 0.42
Organic matter	69.30 ± 0.44	72.41 ± 0.37
Crude protein	65.60 ± 0.39	68.49 ± 0.36
Crude fat	60.59 ± 0.41	60.00 ± 0.47
Crude cellulose	58.50 ± 0.68	60.81 ± 0.45
Nitrogen-free extractives	76.01 ± 0.48	79.89 ± 0.50

Table 5 – Use of the diet nitrogen by test steers, g (n = 3)

Indicator	Group	
	control	3 test
Consumed nitrogen	159.17 ± 0.48	159.26 ± 0.50
Excreted nitrogen in feces	55.98 ± 0.45	50.44 ± 0.40
Excreted nitrogen in urine	72.94 ± 0.41	74.18 ± 0.31
Deposited in the body	30.25 ± 0.26	34.64 ± 0.36
Used nitrogen, %:		
of consumed	19.01 ± 0.29	21.75 ± 0.34
of digested	29.31 ± 0.38	31.83 ± 0.47

It was found that the nitrogen balance in the steers of the control and third test groups was positive in all cases. However, in the process of heavy metal detox by joint feeding the enzyme preparation Celloviridin G20x and adsorbent Toxfin, the counterparts of the third test group vs. the control for a day deposited 4.39 g (P<0.05) more nitrogen in the body. The data obtained show that the level of feed nitrogen use corresponded to the average daily body weight gain of the test fattening young cattle. Our data are consistent with the data obtained by a number of authors (Dzodzieva et al., 2015; Vityuk et al., 2017)

In the process of heavy metal detox, the body of steers in the third test group showed compared to the control, a significant (P<0.05) increase in the level of nitrogen use of the consumed with feed amount by 2.74% and of the digested amount – by 2.52%.

Conclusion. To increase the digestibility and use of nutrients in feeds with increased heavy metal level, the enzyme preparation Celloviridin G20x at a dose of 70 g/t and adsorbent Toxfin at a dose of 1 kg/t mixed feed should be jointly included in the diets of fattening young cattle.

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