

# Special Features of Lactating Cows Digestion affected by Epofen and Toxisorb

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## Abstract

**Background/Objectives:** The purpose of this research was to study the efficiency of using Epofen antioxidant and Toxisorb toxin binder in the rations of lactating cows to improve metabolic processes in their bodies. **Methods/Statistical analysis:** A scientific and economic experiment was conducted in lactating cows of black-motley breed according to the following scheme: control group cows received BR (basic ration), Epofen was added to the first experimental group BR in an amount of 3 g per head, Toxisorb was a supplement to the second group BR in an amount of 1,500 g/t of fodder, the third group ration contained both studied supplements at the indicated doses. **Findings:** The research has established that in the feeding conditions of the North Caucasus to enhance the physiological and biochemical status of the lactating cows their diets should include together Epofen and Toxisorb in the specified amount. Joint supplementation provided increase in total and albuminous nitrogen by 4.9 and 48.3%, respectively, and reduction of non-albuminous and ammonia nitrogen by 18.7 and 15.4%, respectively, in animals of the third experimental group relative to the control one. The total count of VFA (volatile fatty acids) made 9.14; 8.82 and 9.84 mmole/100 ml, respectively, in the rumen fluid of animals of the experimental groups versus 7.96 mmole/100 ml the in the control group. Studies on the digestibility of nutrients found that cows of the third experimental group had reliably higher coefficients of digestibility of dry and organic matter by 3.2 and 3.3%, respectively, of crude protein – by 3.6%, of fiber – by 4.5% and NFES (nitrogen-free extractive substances) – by 4.2%; their rates of nitrogen utilization for milk production from the received and digested amount were higher by 3.12 and 3.71%, respectively. **Applications/Improvements:** The research results have been implemented on the entire population of lactating cows in the region and adopted for the implementation by the Ministry of Agriculture and Food of the Republic of North Ossetia-Alania. They are also used in the educational process at the departments of technology management and veterinary medicine of Gorsky State University of Agriculture.

**Keywords:** Antioxidant, Cows, Digestion, Lactation, Toxin Binder

## 1. Introduction

Modern technologies in dairy cattle breeding are based on the principle of producing the competitive and environmentally-friendly products with maximum use of special biological features of lactating cows' gastrointestinal tract structure.<sup>1-3</sup>

Hence, improving the milk productivity of cows is closely related to the normal course of physiological processes in the organism, where digestion process

fulfills one of the most important functions among other processes. Digestion system is most dynamic in the organisms of the ruminant animals and it deploys varied range of adaptive transformations. The location of the principal processes of the feedstuff nourishing elements bacterial fermentation is in the rumen.<sup>4-7</sup>

Although, there are no endogenous ferments in the rumen, practically all nourishing elements from the feedstuff, entering the rumen, undergo profound transformation there, which becomes possible due to the

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microscopic flora activity. At that, the life of the rumen microflora is supported by definite conditions, by relevant feedstuff assortment and quality.

In the rumen, protein undergoes hydrolysis with microorganisms being reduced to peptides, amino acids and ammonia, which are further used in the protein synthesis for the bodies of the microorganisms proper.<sup>8-10</sup>

Then, quite considerable amount of microbial protein, generated in the course of the rumen microflora activity, comes to the intestines and is utilized by the host organism. It is believed, that the biological value of the microbial protein is higher than that of the protein from the vegetative feedstuff.

The microflora of the rumen is capable of synthesizing a considerable amount of polysaccharides, which are digested and absorbed in the thin section of bowels in the same way as the proteins are. The potential to accumulate polysaccharides is most characteristic of infusoria. It is believed that the ability of protozoa to accumulate polysaccharides in their bodies is a very important adaptive feature of their organisms, and it is very significant not only for the activity of microorganisms but for the host animal as well. Polysaccharides, accumulated by the rumen microflora, are then hydrolyzed in the lower sections of the digestive tract, being reduced to monosaccharides and absorbed into the blood stream.<sup>11-13</sup>

Due to the intensive development of the processes in the rumen, the level of metabolites in its chyme is quite variable. Therefore, the intensity and the trends of apolexis and biosynthesis in the rumen are evaluated based on the concentration of particular metabolites.

## 2. Materials and Methods

To solve the issues under investigation, 4 groups of 10 animals each were formed using the method of counterpart pairs from 40 cows of the black-and-white breed, selected with a view to their breed representativeness, calving age, live weight, date of the last insemination, productiveness over the previous lactation and the fat content in the milk.

According to the feed pattern, the cows from the benchmark group were fed with BD. Antioxidant Epofen was admixed in the amount of 3 g per animal to the BD for their counterparts from the 1<sup>st</sup> experimental group, sorbent Toxisorb was admixed in the amount of 1500 g/t of feedstuff to the BD for the 2<sup>nd</sup> experimental group, the preparations of antioxidant Epofen in the amount of 3 g per animal and sorbent Toxisorb in the amount

of 1500 g/t of feedstuff were added to the BD for the 3<sup>rd</sup> experimental group.

The feeding of the trial cows was implemented in line with the diet balanced in conformity with the detailed regulations developed at All-Russian Research Institute of Animal Husbandry, depending on the season and in accordance with the work schedule at the farm. In preparing the diet for the trial animals, the sugar-protein ratio has been strictly adhered to by means of feeding the cows with beet molasses.

In the course of the experiment, the ruminal digestion in the middle of lactation was investigated with 3 cows from each group applying the method of N.V. Kurilov and others.<sup>14</sup>

The state of the ruminal digestion was evaluated by means of probing and by taking samples of the contents one hour before feeding.<sup>14</sup> In the contents, the following parameters were investigated: pH value by the electrometric method with the help of pH-meter; ammonia concentration by Conway's microdiffusion method; total concentration of VFA, namely, oleic acid, propionic and acetic acids by Markham method; the number of infusorias was calculated in Goryaev chamber; total number of bacteria was calculated with the microscope studying the smear of the rumen contents.

Studying the effect of the investigated drugs on the nourishing elements digestibility, and also on the absorption of nitrogen, calcium, phosphorus was implemented using the method of N.I. Ovsyannikov.<sup>15</sup>

The obtained material was processed by Student's variation statistics method drawing the validity criterion for the variances in the groups of the trial animals according to Ye.K. Merkurjeva.<sup>16</sup>

## 3. Discussion

It is believed that, due to the microbial destruction of mycotoxins by ruminants, the bovine cattle are less affected by mycotoxins. However, the undertaken investigations make it safe to maintain that the ruminal destruction of mycotoxins is insignificant, and at that, some mycotoxin breakdown products can be even more toxic than the initial compound elements.

Therefore, some indicators have been studied which characterize the level of ruminal metabolism, associated with feeding Epofen and Toxisorb at the current feedstuff background (Table 1).

**Table 1.** Cows' ruminal metabolism indicators (n = 3)

Indicator	Group			
	benchmark	1 trial cows	2 trial cows	3 trial cows
Nitrogen, mg%:				
- total	122.4±5.96	132.2±4.54	129.6±3.98	136.2±6.14
- non-protein	46.3±3.22	43.4±4.22	44.6±2.32	42.8±2.69
- protein	76.1±4.38	88.8±5.78	85.0±2.88	93.4±4.68
- ammonia	16.2±4.12	14.4±2.32	14.9±2.38	13.8±1.89
- pH	6.84±0.12	7.02±0.10	6.98±0.09	7.08±0.08
VFA, mmol/100 ml	11.12±0.16	11.89±0.14	11.70±0.18	12.00±0.16
Incl., %: acetic	62.16±0.29	64.98±0.32	64.46±0.30	65.39±0.38
propionic	19.89±0.20	20.02±0.22	19.96±0.24	20.16±0.14
oleic	12.56±0.19	9.69±0.16	10.48±0.20	9.14±0.19
Flavobacterium vitarumen, thous./ml	122±1.8	144±1.9	138±2.1	150±2.2
Infusoria, thous./ml	568±3.2	712±2.9	690±3.0	739±2.5
Cellulose activity, %	14.35±0.48	16.98±0.52	16.44±0.46	17.59±0.62
Proteinase activity, %	43.12±0.38	45.98±0.42	45.64±0.34	46.42±0.36

The intensity of the nitrogen-bearing matter disintegration and of the bacterial protein synthesis in the rumen is usually described in terms of the content of total, non-protein, protein and ammonia nitrogen. As the tables show, feeding Epofen and Toxisorb with the diet pattern affected the processes of the microbial protein biosynthesis in the rumen positively. Thus, in the 3<sup>rd</sup> group of the trial cows the content of exchangeable nitrogen in the chyme of the rumen increased by 11.2%, that of the protein nitrogen increased by 22.7%, and the content of ammonia nitrogen decreased by 14.9%, as compared to the benchmark group.

The reaction of the rumen contents in a healthy animal with normal feeding pattern is kept constant within pH range of 6.5-7.4.

In this study, the improved microorganism species composition, their more intense activity and formation, better absorption of organic acids and ammonia, as well as the improved rumen and the mat motion function are associated with the pH value observed in the 3<sup>rd</sup> group of the cows, which is by 0.24 points higher, as compared to that in the benchmark group.

Combined use of Epofen and Toxisorb in feeding the cows of the 3<sup>rd</sup> group resulted in verifiably increased number of infusorias in the pre-stomachs by 30.1% and in the improved cellulolytic activity in the rumen contents by 22.5%, as compared to the benchmark counterparts ( $P > 0.95$ ).

In the fore-stomachs of the cows from the 3<sup>rd</sup> experimental group the growth of the vitamin synthesizing bacteria, *Flavobacterium vitarumen*, proved to be more intensive by 22.9% as compared to the benchmark counterparts ( $P > 0.95$ ).

All those data testify of the fact that feeding Epofen and Toxisorb with the dieting pattern activates biosynthesis processes in the rumen of the cows.

The final products of carbohydrate fermentation in the rumen are represented by VFA (volatile fatty acids), namely, acetic acid, propionic and oleic acids, etc. Therefore, the alterations in the protein biosynthesis intensity in the rumen can be stipulated by the intensity of fermentation processes, which result in generating energy for the microflora growth and development. This assumption has predetermined the idea that the output of the bacterial protein can be predicted based on the number of hexoses, that underwent fermentation in the rumen, and also, based on the number of VFA, generated in the course of this process.

Reasoning from this fact and taking into account the variety of the processes of biosynthesis in the rumen of the trial animals, the concentration of VFA and their correlation in the chyme have been investigated in this study. Based on the results of the investigations it was established that the combined feeding of Epofen and Toxisorb with the dieting pattern resulted in the increase of the total contents of VFA by 7.9% in the chyme of the

rumen in the 3<sup>rd</sup> group of the trial cows, as compared to the benchmark counterparts, which is an indirect indicator of the increased intensity of the fermentation processes in the rumen of the cows affected by the biologically active dieting supplements under investigation. It should also be noted that when these preparations were fed with the dieting pattern the trend has been discovered indicating the alteration in the character of the fermentation processes with the shift to the propionic acid fermentation process.

It has been established that within the contents of the rumen in the 3<sup>rd</sup> group of trial cows the content of acetic acid, which is the major source of the milk fat, was higher by 5.1%, as compared to the benchmark counterparts ( $P > 0.95$ ).

Consequently, combined admixing of Epofen and Toxisorb in the locally prepared dieting patterns for lactating cows, improve the intensity of the fermentation processes, thus resulting in the increased intensity of the biosynthesis processes in the rumen.

To study the effect of feeding Epofen and Toxisorb with the dieting pattern on the digestibility and on

absorbing the nourishing elements in the organisms of the trial cows, a physiological (balance) experiment was carried out.

The results of the physiological experiment have shown that the combined feeding of the antioxidant and the sorbent with the dieting patterns ensured the highest level of the digestion processes; due to the improved composition of microflora in the fore-stomachs and due to the intensified synthesis of proteinase, cellulase and amylase in the gastro-intestinal tract, the hydrolyses of raw protein, of raw fiber and that of the NFES have become more active (Table 2).

As a consequence, the cows from the 3<sup>rd</sup> experimental group revealed better digestion of dry matter by 3.2, that of the organic matter by 3.3, that of the raw protein by 3.6%, that of the raw cellulose by 4.5 and that of the NFES by 4.2%, as compared to the benchmark counterparts ( $P > 0.95$ ).

The animals from other experimental groups, with regard to the abovementioned indicators, also were ahead of those from the benchmark group, but they fell short of the animals from the 3<sup>rd</sup> experimental group.

**Table 2.** Coefficient of diet nutrient digestibility of trial cows (n = 3)

Indicator	Group			
	benchmark	1 trial	2 trial	3 trial
Dry substance	66.2±0.42	69.0±0.48	68.6±0.48	69.4±0.52
Organic substance, %	67.9±0.49	70.4±0.50	70.0±0.46	71.2±0.44
Raw protein	64.9±0.29	67.6±0.38	67.2±0.34	68.5±0.34
Raw cellulose	62.4±0.42	66.3±0.44	66.1±0.49	66.9±0.52
Raw fat	56.8±0.38	59.4±0.35	58.6±0.42	60.0±0.32
NFES	78.6±0.58	82.0±0.52	81.6±0.60	82.8±0.58

**Table 3.** Trial cow's nitrogen utilization balance, g/per capita (n = 3)

Indicator	Group			
	benchmark	1 trial	2 trial	3 trial
Taken with feed	281.14±1.34	280.62±1.08	281.43±1.85	281.06±1.02
Excreted with:				
- manure	98.76±2.34	90.93±2.48	92.38±1.96	88.51±2.83
- urine	92.12±1.22	86.69±1.69	88.91±3.08	86.89±1.96
- milk	78.72±1.76	87.06±2.04	85.45±1.44	89.12±1.81
Digested	182.38±2.33	189.69±1.54	189.05±0.98	192.55±1.28
Nitrogen balance, g	11.54±0.48	15.94±0.44	14.69±0.38	16.54±0.50
Nitrogen-to-milk utilization, %:				
- from consumed amount	28.00±1.28	31.02±0.98	30.36±1.29	31.71±1.02
- from digested amount	43.16±1.92	45.89±1.96	45.02±1.80	46.28±1.68

The lactation performance is, to a large degree, predetermined by the absorption of the plastic material of the feed, and, in the first place, by the absorption of protein. Therefore, in the course of physiological experiment, to study the character of the feedstuff protein utilization by the lactating cows more profoundly, the balance of nitrogen in the organisms has been investigated.

Based on the data from the balance experiment and from the chemical analyses of the feedstuff, of the remnants, of manure and urine, the nitrogen balance has been investigated, which represents an indicator of the protein utilization in the organism of an animal (Table 3).

Analyzing the balance data and the data from the physiological experiment on the protein utilization by the trial cows, it should be noted that nitrogen consumption with the feed was practically the same in all experimental groups.

At that, the cows from those groups, in which the drugs under investigation were fed with the dieting patterns, revealed more intensive nitrogen digestion. Thus, the highest nitrogen digestibility indicator has been established with the lactating cows fed with combination of Epofen and Toxisorb with the dieting pattern, which manifested in the fact that the cows from the 3<sup>rd</sup> experimental group revealed the intensity of nitrogen digestion higher by 10.17 g or by 5.6%, as compared to the benchmark counterparts ( $P > 0.95$ ).

The excretion of nitrogen with milk protein was in conformity with the productivity level of the cows in the experimental groups.

It has been established that feeding the drugs under investigation to the trial cows with the dieting pattern resulted in better utilization of nitrogen for protein synthesis in the milk of the cows from the experimental groups. Thus, in the 3<sup>rd</sup> group of the trial cows' nitrogen excretion with milk amounted to 89.12 g versus 78.72 g in the benchmark group which is by 13.2% more to the advantage of the 3<sup>rd</sup> group ( $P > 0.95$ ). The improved digestion and better utilization of nitrogen for the milk protein synthesis is confirmed by the fact that, in terms of the nitrogen-to-milk utilization parameter, the cows from the 3<sup>rd</sup> group were ahead of the benchmark counterparts as regards the consumed amount of nitrogen by 3.71%, and as regards the digested nitrogen by 3.12%, in absolute units ( $P > 0.95$ ).

Nitrogen retention in the bodies of the trial animals in all groups were positive, at that, it should be noted that

in the cows from the benchmark group it was the lowest.

Thus, the cows from the 3<sup>rd</sup> experimental group, fed with the mixture of the biologically active dietary supplements under investigation with the routine diet pattern, used to retain in their bodies 16.54 g of nitrogen per day on average, which is by 5.00 g or by 43.3% more, as compared to the benchmark group ( $P > 0.95$ ). More intensive retention of nitrogen per day in the bodies of lactating cows from the experimental groups is an indirect indicator testifying of the better development of the fetus in the organism and of the improved fitness of the organism for the next lactation.

It can be concluded that the digestibility of the nitrogen-containing compound elements was positively affected by feeding Epofen and Toxisorb to the animals of the experimental groups, which is associated with the fact that in the case of the animals from the experimental groups, in contrast to those from the benchmark group, the more native proteins were coming from the stomach to the intestines. This assumption is in conformity with the results of biochemical investigations of the samples from the rumen chyme and of the blood samples.

As is well known, the mineral elements entering the organism of an animal are used as the structural material in forming their skeleton; they also participate in generating the products, in the processes of growth, reproduction, metabolic conversion, etc.

Therefore, mineral metabolism, especially metabolism of calcium and phosphorus in the organisms of lactating cows, is of great significance.

The amount of calcium and phosphorus, required for the cows, is determined by their absorption from the feedstuff, by endogenous losses of these elements with manure and urine, by excretion with milk and by retention in the body. In relation to the biologically active preparations used in the diet patterns, in this study the specific features of mineral metabolism have been investigated with the trial animals. The data on calcium and phosphorous balance and utilization are represented in Table 4.

Based on the results of the physiological experiment it was established that feeding Epofen and Toxisorb with the routine diet, both separately and in combination, affected calcium utilization by the cows from the experimental groups positively. Thus, the cows from the experimental groups used to excrete with milk 21.08; 20.86 and 21.12 g of calcium per day on average respectively versus 18.84

**Table 4.** Trial cow's calcium and phosphorus utilization balance (n = 3)

Indicator	Group			
	benchmark	1 trial	2 trial	3 trial
	<b>Calcium</b>			
Taken with feed	78.21±1.04	78.36±0.71	78.19±0.85	78.26±1.02
Exuded with:				
- manure	40.93±1.29	37.53±2.21	37.93±1.68	37.16±1.39
- urine	0.62±0.06	0.71±0.03	0.72±0.02	0.69±0.04
- milk	18.84±0.68	21.08±1.08	20.86±0.88	21.12±0.91
Balance, g	17.82±1.78	19.04±2.34	18.68±0.93	19.29±1.18
Calcium-to-milk consumption, %	24.09±1.22	26.90±0.96	26.67±1.31	26.98±1.22
Total calcium consumed, %	46.87±1.02	51.19±1.26	50.56±1.52	51.63±1.48
	<b>Phosphorus</b>			
Taken with feed	57.26±0.88	57.29±0.93	57.38±1.02	57.32±0.69
Exuded with:				
- manure	28.82±1.46	27.38±0.86	27.65±0.63	27.12±0.94
- urine	1.62±0.32	1.72±0.29	1.64±0.48	1.69±0.31
- milk	14.48±0.58	15.56±0.74	15.52±0.62	15.82±0.52
Balance, g	12.34±1.02	12.63±0.96	12.57±1.16	12.69±0.97
Phosphorus-to-milk consumption, %:	25.28±1.26	27.16±0.94	27.04±1.08	27.60±0.92
<b>Total phosphorus consumed, %:</b>	<b>46.83±1.78</b>	<b>49.20±1.36</b>	<b>48.95±1.64</b>	<b>49.73±1.68</b>

g in the benchmark group, which is by 11.8; 10.7 and 12.1% more to the advantage of the animals from the experimental groups ( $P > 0.95$ ).

As regards daily calcium retention in the body, the cows from the 3<sup>rd</sup> experimental group were ahead of the benchmark counterparts by 1.47 g or by 8.2% on average ( $P > 0.95$ ), which can testify indirectly of the better development of the fetus in the uterus of the animal and also of reserving the nourishing elements for future lactation performance.

Investigations of phosphorus metabolism in the organisms of the trial cows, showed its correlation with calcium metabolism within the overall framework of mineral metabolism.

It has been established that the animals from the experimental groups used to excrete this macro-element with milk by 7.4; 7.1 and by 8.2% more intensively, than the animals from the benchmark group. At that, it should be noted that the balance of phosphorus was positive in all trial groups.

Thus, studying calcium and phosphorus metabolism in the physiological experiment it has been established that, notwithstanding some minor difference in consumption and absorption, the cows from the experimental groups demonstrated positive and, at that, quite high retention value and utilization value for those mineral elements, which

proved that, in terms of minerals, the trial animals were fed adequately.

## 4. Conclusion

Feeding the mixture of the abovementioned biologically active dietary supplements with the routine diet pattern activated the processes of rumen metabolism, thereby verifiably increasing pH value by 0.24 points, increasing the number of infusoria by 30.1, improving cellulase activity by 22.5, stimulating the growth of the vitamin synthesizing bacteria by 22.9, improving the proteolytic activity of the rumen liquid by 3.30, increasing the molar contents of VFA by 7.9 and the concentration of acetic acid by 5.1% in the rumens of the cows from the 3<sup>rd</sup> experimental group, as compared to the counterparts from the benchmark group ( $P > 0.95$ ).

Based on the results of the physiological experiment it has been established that the cows from the 3<sup>rd</sup> experimental group revealed verifiably higher quotients of digestibility of the dry and of the organic matter by 3.2 and by 3.3 respectively, that of the raw protein by 3.6, that of the cellulose by 4.5 and that of the nitrogen-free extractive substances by 4.2%; the indicators of nitrogen-to-milk utilization in relation to the consumed and to the digested amount used to be higher by 3.71 and by 3.12% respectively ( $P > 0.95$ ).

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