

Comparative study of rations for milking cows with soybean meal or cake added to the diet in equivalent amounts for metabolizable protein

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Abstract

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The studies were carried out on two groups of novice cows ($n = 0$, average weight of 650 kg, average daily yield of 26 kg) from 30 to 100 days of lactation. The diet of the cows of the first group included soybean meal, and diet of the cows of the second group – the soybean cake in equivalent quantities for the exchange protein, previously estimated in experiments on operated cows. There were no significant differences in the parameters of enzymatic-microbiological processes in rumen, biochemical indicators of blood, milk productivity and milk composition.

Keywords: dairy cows; soybean meal; soybean cake; metabolizable protein; rumen digestion; milk production

Introduction

The problem of protein nutrition in agricultural animals is one of the most urgent in modern livestock breeding. It is restrained by the inadequate production of high-protein feed, the effectiveness of their use and cost. The nutritional value of the protein for ruminant feed increases significantly if it is relatively resistant to the rumen microflora and at the same time is well digested in the intestine. However, the assortment of fodders with low protein degradation (RP) is very limited, and most of them are expensive, which makes their use at times economically unreasonable. In practice, the main criterion in choosing a product remains the price of 1 g of protein feed. The use of reference data on the RP of one class of feed is not enough, since the data can vary considerably depending on the technology of production of the product and the raw materials used, which makes it impossible to use these data with certainty, and manufacturers regulate only the content of raw protein and urease activity. Thus, comparing the characteristics of the protein value of various soy foods ($n = 20$) as the most common products with reduced degradability, obtained both from Russian factories and im-

ports (cakes and meal cakes) Kharitonov (2010) shows that, depending on technological regimes adopted at various processing enterprises (shell stripping, extrusion), spinning for cakes, testing modes for meals, products with final efficiency are obtained (availability to absorption after digestion in the intestine of no degradable protein in the rumen), differ by almost a factor of 2. This does not make it possible to make an unambiguous choice not only between producers of the same product, but even between meals and oilcakes.

In connection with this, the purpose of our research was the scientific and practical justification for the use of protein feeds, taking into account the composition of their protein, degradation in the rumen and the digestibility of the undegradability part in the intestine when feeding dairy cows.

Materials and Methods

Fulfilled work was made in accordance with ethical principles established by the European convention on vertebrates' protection which are used for experimental and other scientific purposes (adopted in Strasbourg 18.03.1986 and ratified in Strasbourg 15.06.2006). The work was approved by ethic

Committee of the All-Russian Scientific Research Institute of Physiology, Biochemistry and Nutrition, Borovsk (Kaluga region, Russia) (Protocol №3 from 18.04. 2016).

Study site, experimental procedure, design and treatments: For the decision of tasks in view experiences on cows Black-and-White breed in conditions of vivarium of All-Russian Scientific Research Institute of Physiology, Biochemistry and Nutrition have been carried out. To conduct the experiment, two groups of novice cows – analogues (average live weight 650 kg > 28 d post partum, average daily initial yield of 26 kg) were formed according to live weight, milking and age, 10 heads each. The rations of cows have been optimized on structure of metabolizable energy and a metabolic protein, agrees the norms of a feeding nutritional requirements according to recommendations developed by NRFFA (2003). The experiment was carried from 30 to 100 days of lactation. Group I cows included soybean meal in the diet, Group II – soybean cake in equivalent amounts according to the metabolizable protein, previously estimated in experiments on operated cows. Three non-lactating dry cows of the Black and White Breed with rumen and duodenum fistula were used for determination of crude protein degradability into rumen and digestibility in the intestine. Bags with samples were inserted into rumen before the morning feeding, except for those for 12 hours incubation time in the rumen. The effective degradability of feed protein was calculated from the data of the relative degradability in the rumen determined by in sacco method and the rate of evacuation from the rumen (Ørskov and McDonald, 1979). The metabolizable protein was determined from the sum of the digested non-degradable protein – the method of mobile bags (Voigt et al., 1985) and the microbial protein digested in the intestine (Kharitonov, 2008).

In all periods of the experiment each cow obtained a ration from keeping 50-60% of concentrated foods on nutritiousness. The feeding of cows was twice a day at 8.00 and 18.00. Cows were milked twice daily and yields were recorded.

Data collection: During experiences led the daily count of amount of the consumed forages, chemical structure of forages of a ration was defined. Samples of blood of a jugular vein took a puncture of vessels up, and through 8 after a morning feeding; serum was preserved at -20°C until analy-

sis. To determine the biochemical parameters of blood in all animals of each group, blood was taken from the jugular vein in 3 hours after a morning feeding.

Samples of a rumen liquid obtained before and after 3 and 5 hours after morning feeding with the help esophagus a probe. Samples of milk from three consecutive days were combined according to yield for each day and for each cow and were analyzed.

Chemical analysis: The chemical composition of feeds was analyzed according to methods of Kalnitsky et al. (1997). The gross energy of the diets and excreta samples was determined using an adiabatic bomb calorimeter (ABK-1, Russia). Milk composition was determined using a Milkotester (Lactostar, Italy). Parameters of microbiological processes was determined in rumen: pH, VFA and their ratio on a gas chromatograph using apparatus Martgama (Colour – 800, Russia), ammonia diffusive method Convey, number of bacteria and protozoa, amylolytic and cellulolytic activity (Kurilov et al., 1987).

The concentration of urea and glucose in whole blood samples was determined using the test systems BIO-LATEST (PLIVA-LACHEMA DIAGNOSTIKA, Czech Republic), ketone bodies, nonesterified fatty acids (NEFA), triacylglycerols – by enzymatic colorimetric method (the panel of reagents of firm Soared Diagnostic Spb), loose amino acids (on amino acid analyzer AAA-T400, Czech Republic).

Statistical analysis: The statistical processing of the data was done in the SPSS for Windows 11.5 computer program. The differences between treatments were then estimated using the LSM method. $P < 0.05$ was considered significant.

Results and Discussion

In experiments conducted on operated cows in the Institute vivarium, when comparing the effectiveness of using soybean meal and soybean cake, the parameters of their protein nutrition (degradability of protein and digestibility of non degradability crude protein (SP) are established (Table 1). Comparison of different protein feeds for these characteristics is widely used in assessing the protein nutrition of both individual feeds (Yildiz & Todorov, 2014; Todorov et al., 2016; Nedelkov et al., 2017) and diets as a whole (Yildiz, 2015).

Table 1. Parameters of protein nutritional value of the studied forages of natural moisture

Groups	Crude protein (SP), %	Effective degradability SP, % at $k = 0.08$	Digestibility of non-degradation SP, %	Availability for assimilation, %	Metabolizable protein (g), per 100 g of feed
I – soybean meal	47.7	42.5	90.2	51.8	24.7
II – soybean cake	36.7	32.5	92.7	62.5	22.9

The content of the available SP in the meal was higher in comparison with soybean meal (24.7 and 22.9 g per 100 g), and therefore the norms for the introduction of protein feeds into rations were calculated to ensure the same amount of exchange protein in the rations (Table 2). The diets of the cows from Groups I and II had the same content of metabolizable energy and protein. In the diet of Group II, there was more raw fat by 28% (Table 2), due to its high content in soybean cake.

Table 2. Cow feeding diets during the experiment

Feed	Groups	
	I	II
Hay grain, kg	0.5	0.5
Mixed silage, kg	13.7	13.7
Corn silage, kg	33.7	33.7
Concentrates, kg	8.5	8.5
Gluten feed, kg	2	2
Molasses, kg	1	1
Soybean meal (tasted), kg	1.4	–
Soybean cake, kg	–	1.5
<i>The diet contains</i>		
Metabolisable energy, MJ	200,0	201,1
Dry matter, kg	21,2	21,3
Crude protein, g	3022	2963
Degradation protein, g	1849	1827
Undegradation protein, g	1173	1135
Crude fat, g	635	760
Neutral-detergent fiber, g	7413	7495
Crude fiber, g	3133	3256

The study of parameters of rumen content of cows showed that in the experimental groups there were no significant differences in the indices (Table 3). Among the microbiological indicators, a tendency has been observed to reduce the number of protozoa and increase the number of

Table 3. Parameters of enzymatic microbiological processes in cows rumen in the experiment (M±SE, n = 5)

Parameters	Groups	
	I	II
pH	6.75±0.13	6.5±0.05
NH ₃ mean, mg dl ⁻¹	7.48±0.68	8.1±1.3
Total VFA, mM	8.1±0.89	9.6±0.7
Acetate, molar % of VFA	60.7±1.27	62.0±1.5
Propionate, molar % of VFA	24.3±0.42	22.8±2.8
Butyrate, molar % of VFA	14.9±1.23	10.4±2.2
Bacterium 10 ⁶ ml ⁻¹	10.2±1.16	11.9±0.1
Protozoa, x 10 ⁵ ml ⁻¹	368.3±30.8	296±57.5
Amylolytic activity, E dl ⁻¹	29.9±2.2	31.7±2.5
Fibrolytic activity,%	15.8±0.31	16.1±0.3

bacteria in the contents of the rumen in cows receiving soybean meal ($p > 0.05$).

Thus, the use of comparable feeds provided scar tissue microflora with nitrogenous (ammonia level) and energy components (level of VFA), and also had no significant effect on its state (the number of bacteria and protozoa, their enzymatic activity). The use of protein foods with different disintegration in rations. When comparing protein foods with different disintegration, a change in rumen digestion is usually observed (Ruzic-Muslich et al., 2013), but in our experience the total amount of disintegrated protein in the diets between the groups did not differ.

The study of blood biochemical parameters of experimental animals showed no significant changes. Because of the same amount of disintegrating protein in the rumen and the digestible undegradation protein in the intestine, both the level of ammonia in the rumen and the concentration of amine nitrogen and urea in the blood did not differ. The increase in the milk productivity of cows in the groups during the experiment was not accompanied by an increase in the degree of mobilization of fat stores, as evidenced by the ketone bodies in the blood (Table 4).

Table 4. Indicators of blood of cows in the experiment (M±SE, n = 5)

Parameters	Groups	
	I	II
Amine nitrogen, mg%	4.94±0.17	4.98±0.126
Urea, mg%	22.7±5.79	23.7±1.74
Glucose, mmol/L	3.17±0.35	2.5±0.32
Sum of ketone bodies, mg%	3.6±0.66	3.4±0.58
Triglycerides, mg%	13.0±3.45	10.5±0.91
Cholesterol, mg%	162±12.2	100.3±1.55

At the beginning of the experiment (28th day of lactation), cows had one level of milk productivity in the groups (Table 5). After 2 weeks from the beginning of feeding the protein supplements, the milk productivity increased by 8.8% and 28.7% in Group I and Group II, respectively, compared to the initial milk yield, with the difference between the groups being 17.3%. After 45 days, the productivity in Group II decreased slightly and the difference from Group I was only 3.7% higher and by the end of the experiment it remained at the same level. After the end of feeding in Group I there was a more progressive decrease in productivity. For the entire period of observation, the average daily yield in Group I was 27.3 ± 0.82 kg, and in Group II – 27.6 ± 1.77 kg. Yield of cows receiving soybean meal increased only at the beginning of the experiment, and by the end of the experiment its decrease was noted. Productivity was not restored even after the transfer of cows to the same rations.

Table 5. Average daily yield of cows in the period of experience (M±SE, n = 10)

Groups	Before the experiment (28 th day of lactation)	On the 15 th day from the beginning of the experiment (45 th day of lactation)	On the 45 th day from the beginning of the experiment (75 th day of lactation)	On the end of the experiment (100 th day of lactation)	On the 130 th day of lactation	On the 160 th day of lactation
I	26±1.25	28.3±2.84	29.6±3.71	29.0±2.1	26.6±3.2	24.3±2.8
II	25.8±1.3	33.2±2.2	30.7±2.88	30.1±1.9	23.6±4.2	22.3±3.9

Table 6. Composition of milk and the release of fat and protein with milk during the experiment (M±SE, n = 10)

Parameters	Groups	
	I	II
Fat, % (15 days of experience)	3.79±0.54	3.52±0.18
Milk fat production, g	1045±69.9	883.5±104
Fat, % (45 days of experience)	3.56±0.12	3.45±0.13
Milk fat production, g	1054±120.6	1044±66.7
Protein, % (15 days of experience)	3.15±0.012	3.2±0.11
Milk protein production, g	891±93.5	1062±54.3
Protein, % (45 days of experience)	3.12±0.066	3.3±0.12
Milk protein production, g	923.5±109.8	1013±109
Urea, mg%	28.4±3.6	26.9±1.86

However, the cows of Group II did not lose less fat and more protein with milk on the 45th day of the experiment (Table 6). In the milk of the Group II cows, a slight decrease in the level of urea (5.3%) was found in comparison with the milk of the Group I cows, which indicates more efficient use of amino acids in the metabolic process, at the same level of absorption of ammonium forms.

Usually when protein foods with different nutritional characteristics are used, the study changes the milk productivity of cows (Todorov et al., 2016). But in the experiment, the protein feeds were introduced into the diet in equal amounts by the exchange protein and therefore no differences in productivity were found.

Conclusions

Thus, in the experiment comparing the effectiveness of the use of soybean meal and soybean cake in rations of cattle, there were no obvious differences, but the time for reconstructing the microflora and fermentative microbiological processes in pancreatic diets on soybean meal was shorter with respect to soybean cake, the efficiency assimilation of fat and its isolation with milk was higher throughout the entire experiment, while the efficiency of conversion of nitrogen to milk protein in cows receiving soybean meal was somewhat inferior to that index of cows

fed with soybean cake.

When comparing two protein feeds, it is established that their introduction into the diet in equivalent amounts by the exchange protein provided that scar tissue microflora is provided with available forms of nitrogen leads to a single productive result and shows an effective approach when choosing and comparing protein feeds.

It is focused on the need for further research to compare other protein sources, and to find a biologically and economically optimal combination of different protein sources in the dairy cows.

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