MEETING THE PROTEIN REQUIREMENT OF DAIRY COWS IN A LONG-TERM FEEDING EXPERIMENT

Ü. Oll, S. Tölp, J. Tölp, H. Pärn

ABSTRACT. *The aim of this work was to compare three possibilities of meeting the protein requirement of dairy cows. Altogether 72 Estonian Red cows with 200 periods of lactation were used in the experiment. The treatments differed in the composition of concentrate feeds as follows: (a) complete concentrate feed (produced in a feed manufacturing plant), (b) barley meal + oil meal, (c) barley meal + urea. Urea was supplied to barley meal at the rate of 2.5 or 3.5 per cent. The ration of each cow was formulated once a month taking into account 6 g/MJ digestible crude protein (DCP) for maintenance and 60 g DCP per 1 kg ECM. One gram of urea was equivalent to 2 g DCP. The milk yield and feed intake of each cow were determined at every milking and feeding, the milk fat content every 10 days, and the milk protein content once a month.*

The results are given per cow and lactation. The milk yield (kg), milk fat and protein content (%), and the milk fat and protein yield (kg) were as follows: (a) 4478, 4.17, 3.555, 186.9 and 159.0, (b) 4556, 4.08, 3.48, 185.7 and 158.6, (c) 4492, 4.11, 3.555, 184.8 and 159.4. The ECM-yield made up: (a) 4594, (b) 4608 and (c) 4569 kg.

On average per cow and lactation the cows consumed the following amounts of metabolizable energy (MJ) and DCP (kg): (a) 39,327 and 354.3, (b) 43,383 and 412.5, (c) 42,424 and 289.4 (without urea) or 381.1 (with urea). The CP content of the rations DM was: (a) 13.8, (b) 15.1, (c) 12.1 (without urea) or 15.6 (with urea) per cent.

It can be concluded that the milk yield was practically on the same level in all the groups. Urea can meet the protein requirement, if it is carefully used. No urea poisoning was noticed.

Key words: *Protein requirement of dairy cows, urea supplement, protein nutrition of dairy cows.*

Animals as well as man need a certain amount of protein in their nutrition. This fact has been known for nearly two centuries. However, many aspects of protein nutrition have not yet been resolved.

Most of difficulties are caused mainly because protein is not a single homogenous compound and therefore its nutrition value is not always the same. Protein as a whole cannot enter the cells of animals; only amino acids and some other low molecular compounds, such as ammonia, creatine etc. which orginate from feed protein can do that. In the feeding of typical nonruminants it is necessary to ensure that the animal obtains enough of each amino acid with its feed as it needs for maintenance, gain and synthesis of production. If, for example, a pig requires 15 g of lysine a day for this purpose, this amount of lysine must be absorbed in the intestine. Actually the feed must contain somewhat more lysine as part of it remains undigested.

The protein nutrition of ruminants and nontypical monogastric animals (horses) is much more complicated. In their digestive tract, microbes come between the absorbing amino acids and these which are components in feeds. They reside either in the rumen (ruminants) or in the large intestine (horses). These microbes consume part of the amino acids taken in with the feed and transform them into their own cell protein. The task of the organism of the animals is to break down microbial protein and to absorb the released amino acids. It is considered that the compositions of the feed and of the microbial protein are not similar. For example, the lysine content of protein is low in one feed and high in the other, the share of lysine in the microbial protein in rumen is similar, while nearly equal amounts of microbial lysine will be synthesized in the rumen. The lysine content of microbial protein is a hereditable characteristics determined by genes.

As early as in the last century, some researchers referred to the fact that this process will be submitted to the activity of microbes in the rumen. Ruminal microbes ferment carbohydrates of feedstuffs into volatile fatty acids (acetic, propionic and butyric acid), and at the same time they do not leave feed protein intact.

Material and methods

Feeding treatments. To meet the protein requirements of the dairy cows, three treatments were used which differed from each other by type of concentrate feed in the ration:

OM – barley meal + oil meal,
MC – complete mixed concentrate feed prepared in a manufacturing plant,
U – barley meal + urea

The mixed concentrate feed had to contain at least 14 % crude protein (the state standard of that time). By the second treatment the amount of added oil meal was calculated from the digestible protein requirement (6 g/MJ for maintenance and 60 g per 1 litre milk) of each cow. Urea was added (3rd treatment) at the rate of 2.5 % (some cows received barley meal containing 3.5 % of urea).

Other feedstuffs in the rations. Other feedstuffs did not differ in these treatments. One half of each group received timothy hay (8 kg a day), the other half chopped dried grass. In summer part of the grass feed was replaced by fresh grass (4 kg hay or chopped dried grass + 20…25 kg fresh grass). In winter potatoes and strew were (also) fed. Of mineral feeds salt and calcium phosphate were used.

Feeding regime. Are cows were individually fed. Each cow had an isolated trough. Before feeding, the feeds given to each cow were weighed. Remaining uneaten feeds were also weighed.

The rations for each cow were compiled once a month.

Cows. For each treatment a group of cows was selected from the herd of Ülenurme Training and Experimental Farm of the Estonian Agricultural Academy. Estonian Red cows were used. As the experiment was carried out over 18 years, the cows entered it at different times. When a cow was joined to the experiment, it remained in one certain group until being removed from the experiment. Depending on different conditions, one to seven lactations were obtained from a cow. All in all 200 lactations were obtained from 72 cows. The list of the cows in the experiment is given in Table 1.

At the beginning of the experiment the cows of the second lactation and older were selected, but later heifers were also joined to the experiment.

Table 1. Average dry matter, crude protein and metabolizable energy content, and the feeding value in FU of the feeds fed in the experiment

Feedstuffs	No of samples	Dry matter %	Crude protein %	MJ ME kg^{-1}	FU kg^{-1}
Timothy hay	205	80.96	8.45	6.75	0.47
Dehydrated grass	104	85.69	10.76	8.71	0.59
Barley straw	113	78.20	3.34	5.20	0.27
Grass	197	17.48	2.81	1.72	0.15
Potato	119	21.41	2.06	2.41	0.25
Barley meal	194	86.53	10.97	11.30	1.09
Wheat bran	133	85.87	14.23	9.46	0.76
Cottonseed oil meal	55	88.30	36.62	9.93	0.84
Sunflower oil meal	98	88.66	35.64	10.26	0.85
Groundnut oil meal	8	88.75	39.21	11.81	1.06
Mixed concentrates	190	85.73	13.92	10.53	1.01
Grain-straw complete feed	105	86.48	9.27	8.99	0.63

Calculating the results. The Experimental Unit was built for 18 cows which were serviced by a milkmaid. The rations were compiled, milk, feeds and feed rests were weight and the primary data were summed up by the leader of the experiment (S. Tölp). Every day supervision in the Experimental Unit was trusted to Ass. Prof. J. Tölp.

The milk of each cow was weighted after each milking. Milk fat was determined three times a month and protein once a month. The cows were weighed once a month. Periodically blood and urine samples were taken (H. Pärn).

The results of the experiment

The results of the experiment are given below as arithmetical means of the groups over a standard period (max. 305 days) of lactation.

1. All lactations

The main results are shown in Table 2.

Milk yield. The actual milk yield of all 200 lactations averaged 4500 kg. It was highest in the OM-group – 4556 kg. The milk yields of the cows in the U-group and the MC-group were 64 kg and 78 kg lower respectively.

The highest ECM yield (4608 kg) was also achieved in the OM-group. However, the advantage of the OM-group over the other groups was smaller in this case than in the actual milk yield.

Milk fat and protein content. The milk fat content exceeded 4 % in all groups and the milk protein content was, on average, around 3.5 %. As to the milk fat and protein content, the differences between the groups were not considerable. So, the average milk fat content in the OM-, U-, and MC-groups was 4.08 %, 4.11 % and 4.17 / respectively.

The milk protein content was equal in the U- and MC-groups (3.55 %) and somewhat lower (3.48 %) in the OM-group.

Milk fat and protein yield. Very few differences between the groups were established in either the milk fat or the milk protein yield. In the milk fat yield the maximum difference between the arithmetical means was only 2.1 kg and in the milk protein yield it was even smaller.

Feed consumption. As the rations of each cow were compiled monthly according to the milk yield of the last 10 days, it was not presumed that the differences between the groups would be similar to those in the milk yield.

The feed consumption was calculated in parallel: in MJ of metabolizable energy and in oats feed units. It is interesting that in the feed consumption calculated as feed units, considerable differences were not noticed, whereas, calculating in metabolizable energy brought out certain differences. Thus, the cows of the OM-groups consumed 43,382 MJ of metabolizable energy but the cows of the U- and MC-groups 959 MJ and 4056 MJ less respectively.

Crude protein consumption. Rations with a sufficient amount of digestible crude protein content were fed to the cows of the OM-group. During lactation they obtained 412.5 kg of digestible crude protein (610.3 kg crude protein) with the feed. The crude protein content of the ration's dry matter averaged 15.1 %.

In the other groups the rations were not balanced as for digestible protein and therefore the digestible protein consumption by the cows of these groups was less, namely 354.3 kg and 289.4 kg in the MC- and U-groups respectively. In the feed dry matter, the crude protein content averaged 13.8 % and 12.1 % respectively. In this case urea as a protein source was not taken into consideration. When urea was also accounted for (1 g urea = 2.9 g crude protein = 2 g digestible crude protein), the crude protein content of the ration's dry matter rose to 15.6 %.

Table 2. The main results of the experiment

	Groups		
	OM	MC	U

No. of lactations	40		64		96	
No. of days in the lactation	294	±15.7	287	±24.1	294	±17.2
Actual milk yield, kg	4556	±912.8	4478	±839.6	4492	±909.3
ECM yield, kg	4608	±887.6	4594	±907.6	4569	±863.1
Milk fat, %	4.08	±0.22	4.17	±0.33	4.11	±0.42
Milk protein, %	3.48	±0.25	3.55	±0.19	3.55	±0.25
Milk fat yield, kg	185.7	±35.4	186.9	±39.2	184.8	±34.9
Milk protein yield, kg	158.6	±29.4	159.0	±29.4	159.4	±31.6
Feed consumption:						
FU	3744	±554.6	3726	±553.0	3771	±499.9
MJ ME	43383	±5951	41806	±5585	42424	±5015
Crude protein, kg	610.3^{c,e}	±96.7	535.4^{d,h}	±81.0	460.7^{g,i}	±59.5
Dig. crude protein, kg	412.5^{c,e}	±83.9	354.3^{d,h}	±57.2	289.4^{g,i}	±43.4
DM, kg	4042^{a}	±524.2	3868	±554.2	3813^{b}	±437.7
Crude protein, % of DM	15.1	±0.88	13.8	±1.14	12.1	±0.77
					(15.6	±0.95)
Feed : milk ratio						
MJ ME per 1 kg ECM	9.41	±0.52	9.10	±0.38	9.29	±0.36
FU per 1 kg ECM	0.81	±0.07	0.81	±0.05	0.83	±0.05

The parameters marked with different letters (a, b, c, d, e, g, h, i) differ significantly from each other statistically.
Difference with significance level $P<0.01$, a and b.
Difference with significance level $P<0.001$, c and d; e and g; h and i.

2. First lactation

Milk yield. The average actual milk yield of 46 lactations was 3716 kg (Table 3). Most productive were the primiparous cows of the MC-group. The milk yield of the cows in the U-group was 106 kg lower than those in MC-group. The milk production of the cows fed concentrates containing barley meal and oil meal (OM-group) was markedly smaller than that of the cows of the other groups.

The ECM- yield in the MC- and U-groups was more than 100 kg higher than the actual milk yield, and in the OM-group it was 76 kg higher.

As there were only 8 lactations in the OM-group, it is possible that the lower milk yield in this group was to a certain extent occasional.

Milk fat and protein content. The milk of primiparous cows of all the groups contained more fat than the milk of older cows. The milk protein content of primiparous cows was also higher. On average, the milk fat content of the cows of the OM-group was lower than in the other groups. The differences between the U- and MC-groups were not significant.

The milk protein content in all the groups was relatively high, 3.60 % or higher.

Milk fat and protein yield. Two groups – the U- and MC-groups – were nearly the same: difference in the milk fat yield averaged 3.4 kg and in the milk protein yield 1.2kg. The cows of the OM-group fell behind, by nearly 20 kg in the milk fat yield and 12.0 kg and 13.2 kg respectively in the milk protein yield.

Feed consumption. The feed consumption, expressed as FU, dry matter of metabolizable energy, was highest in the U-group. This was partly caused by a longer period of lactation (9 days longer than in the MC-group), but this was not the main reason. In the OM-group where the milk yield was the lowest, the feed consumption was also smaller than in the other groups.

Table 3. The average data of the productivity and feed consumption of the primiparous cows

	Groups					
	OM		MC		U	
No. of lactations	8		16		22	
No. of days in the lactation	297	±13.9	293	±19.3	302	±9.42

Actual milk yield, kg	3413	±528.7	3841	±777.7	3735	±857.4
ECM yield, kg	3480	±598.2	3972	±863.3	3878	±506.9
Milk fat, %	4.13	±0.18	4.23	±0.32	4.26	±0.51
Milk protein, %	3.66	±0.14	3.60	±0.19	3.67	±0.19
Milk fat yield, kg	141.1	±25.9	162.4	±38.8	159.0	±21.3
Milk protein yield, kg	125.1	±20.8	138.3	±31.3	137.1	±21.4
Feed consumption:						
FU	3106[a]	±413.1	3270	±524.2	3459[b]	±388.6
MJ ME	36299[a]	±4202	37132	±4949	39688[b]	±3454
Protein consumption:						
Crude protein, kg	501.5[c]	±56.3	475.3[e]	±58.5	425.3[d,g]	±38.8
					(535.2	±58.5)
Dig. crude protein, kg	320.8[c]	±43.8	308.4[e]	±41.5	266.9[d,g]	±23.8
					(342.8	±37.0)
Crude protein, % in DM	14.4	±1.09	13.8	±0.89	11.9	±0.69
					(15.0	±0.78)

The parameters marked with different letters (a, b, c, d, e, g) differ significantly from each other statistically.
Difference with significance level P<0.05, a and b.
Difference with significance level P<0.001, c and d; e and g.

Crude protein consumption. Protein consumption was highest in the OM-group; the cows of this group received an average of 501.5 kg of crude protein or 320.8 kg of digestible crude protein per lactation. The crude protein content in dry matter of the ration averaged 14.4 %. The crude protein content in the dry matter of the ration of the MC-group was smaller – 13.8 %, and therefore the crude protein and digestible crude protein consumption were also smaller here.

If urea is not taken into account, the cows of the U-group consumed only 425.3 kg of crude protein and 266.9 kg of digestible crude protein. The dry matter of the ration contained 11.9 % crude protein on average. However, if the urea was taken into account, the crude protein and digestible crude protein consumption rose to 535.2 kg and 342.8 kg respectively. The crude protein content of the dry matter of the ration averaged 15.0 %.

Feed-milk ratio. If the feed consumption was measured in feed units the feed-milk ratio was 0.89, 0.82 and 0.89 in the OM-, MC- and U-groups respectively.

3. Second lactation

The average data of the milk productivity and feed consumption of the cows of the second lactation are shown in Table 4.

Milk yield. During the second lactation the backwardness of the OM-group disappeared; in fact the milk yield was the highest in just this group – 4391 kg. The actual milk yield was 83 kg less in the U-group and in the MC-group as much as 236 kg less. The ECM-yields in these groups were 4490 kg, 4445 kg and 4230 kg respectively.

Milk fat and protein content. The milk fat content of the cows of the OM-groups was 0.02 % higher than that of the cows of this group during the first lactation. In the other groups the primiparous cows had a higher milk fat content than those of the second lactation: in the U-group 0.05 % and MC-group 0.11 %. Like in the first lactation, the milk fat content of the cows of the second lactation was highest (4.21 %) in the U-group. In all the groups the milk protein content of the cows of the second lactation was lower than that of the primiparous cows. The milk protein content was highest (3.64 %) in the U-group. The differences between the MC- and OM-groups were not significant.

Milk fat and protein yield. The milk fat yield was highest (182.2 kg) in the OM-group. The cows of the U-group produced 0.8 kg milk fat less than this. The milk fat yield was lowest in the MC-group.

The milk protein yield was, however, highest in the U-group; in the OM-group it was 2.5 kg lower and in the MC-group 9.7 kg lower.

Table 4. The average data of the productivity and feed consumption of the second lactation

	Groups					
	OM		MC		U	
No. of lactations	11		11		22	
No. of days in the lactation	289	±16.1	277	±30.8	291	±19.2
Actual milk yield, kg	4391	±841.6	4155	±591.4	4308	±789.0
ECM yield, kg	4490	±858.4	4230	±683.7	4445	±771.9
Milk fat, %	4.15	±0.20	4.12	±0.39	4.21	±0.36
Milk protein, %	3.51	±0.19	3.54	±0.23	3.64	±0.36
Milk fat yield, kg	182.2	±35.2	171.2	±31.2	181.4	±31.7
Milk protein yield, kg	154.1	±29.6	146.9	±22.0	156.6	±30.4
Feed consumption:						
FU	3656	±513.0	3583	±402.9	3679	±483.8
MJ ME	42380	±5491	39673	±3694	41315	±5053
Protein consumption:						
Crude protein, kg	$581.2^{a,e}$	±81.3	480.9^{b}	±43.8	448.6^{g}	±55.9
					(575.6	±74.6)
Dig. crude protein, kg	$390.3^{a,e}$	±71.3	$320.3^{b,c}$	±22.3	$283.0^{d,g}$	±41.1
					(370.5	±52.4)
Crude protein, % in DM	14.7	±0.43	13.2	±1.46	12.1	±0.66
					(15.5	±0.94)

The parameters marked with different letters (a, b, c, d, e, g) differ significantly from each other statistically.
Difference with significance level $P<0.01$, a and b; c and d.
Difference with significance level $P<0.001$, e and g.

Feed consumption. As the rations were compiled monthly according to the milk productivity, there was a certain connection between the feed consumption and milk yield. The milk yield was lowest in the MC-group, and feed consumption was also lowest in this group – 3583 FU or 39,673 MJ. In the U-group the cows obtained 41,315 MJ or 3679 FU and in the OM-group 42,380 MJ or 3656 FU respectively.

Crude protein consumption. As with the primiparous cows, so the requirements of the cows of the second lactation in the OM-group were best met with crude protein. Their ration contained an average of 14.7 % of crude protein in dry matter. The dry matter consumed by the cows of the MC- and U-groups contained 13.2 % and 12.1 % crude protein respectively. With urea, the last value increased to 15.5 %.

4. Adult cows (beginning from third lactation)

The corresponding values are given in Table 5.

Milk yield. The average actual milk yield exceeded 5000 kg in the OM-group, in which the milk yield of the primiparous cows was low. The cows of the U-group produced 4890 kg of milk and those of the MC-group 4850 kg. The ECM-yield was a little higher than the actual milk yield in the OM- and U-group. In the MC-group the difference was 121 kg.

Table 5. The average data of the productivity and feed consumption of the adult cows

	Groups					
	OM		MC		U	
No. of lactations	21		37		52	
No. of days in the lactation	296	±16.1	287	±23.4	292	±18.1
Actual milk yield, kg	5078	±591.0	4850	±591.4	4890	±857.4

ECM yield, kg	5099	±522.4	4971	±801.4	4913	±838.5
Milk fat, %	4.03	±0.24	4.17	±0.31	4.03	±0.39
Milk protein, %	3.42[a]	±0.28	3.54[b]	±0.31	3.48	±0.25
Milk fat yield, kg	204.6	±20.4	202.2	±35.4	197.1	±34.9
Milk protein yield, kg	173.7	±19.9	171.6	±24.1	170.0	±31.1
Feed consumption:						
FU	4033	±392.0	3965	±467.2	3943	±480.7
MJ ME	46608[c]	±4032	44462	±4716	44059[d]	±4996
Protein consumption:						
Crude protein, kg	667.0[e,h]	±72.5	577.0[g,j]	±72.1	480.8[i,k]	±60.6
					(626.1	±74.8)
Dig. crude protein, kg	459.1[e,h]	±67.8	384.3[g,j]	±51.6	301.7[i,k]	±46.8
					(401.9	±55.8)
Crude protein, % in DM	15.5	±0.77	14.0	±1.10	12.2	±0.85
					(15.8	±0.95)

The parameters marked with different letters (a, b, c, d, e, g, h, i, j, k) differ significantly from each other statistically.
Difference with significance level $P<0.05$, a and b; c and d.
Difference with significance level $P<0.001$, e and g; h and i; j and k.

Milk fat and protein content. These characteristics were lower than those of primiparous cows and cows of the second lactation, except the cows of the second lactation in the MC-group. The MC-group exceeded the other groups on both fat and protein content. The milk fat content was equal in the OM- and U-groups, and the milk protein content is higher in the U-group.

Milk fat and protein yield. The milk fat exceeded 200 kg in the OM- and MC-groups. In the U-group it was 2.9 kg below this level. The milk protein yield reached 170 kg in all groups. The differences between the groups were 3.7 kg at most.

Feed consumption. Metabolizable energy consumption varied, taking into account the means of the groups, from 44,059 MJ (U-group) to 46,606 MJ (OM-group). The maximum difference in feed consumption was 90 FU.

Crude protein consumption. During the lactation period the cows of the OM-group consumed 667.1 kg of crude protein and 459.1 kg of digestible protein, the cows of the U-group 186.2 kg and 157.4 kg less respectively. However, if urea is taken into account, the difference were 40.9 and 57.2 kg respectively. The cows of the MC-group received 577.5 kg of crude protein and 383.5 kg of digestible protein. If urea is not taken into account the average crude protein content in ration dry matter was quite sufficient (14.5±16.0 %, Vabariiklik Söötmisalase Uurimistöö Koordineerimise Komisjon, 1995) in the OM-group, but there was a small shortfall in the MC-group and a larger shortfall in the U-group. With urea, the crude protein content of the dry matter of the ration was higher than that in the other groups.

Physiological state of the cows

The physiological state of the cows was estimated by the occurrence of diseases and the results of insemination, blood and urine analyses which were carried out periodically in the Department of Internal Diseases and in the Laboratory of Physiology.

The cows sometimes had disorders and difficulties in fertilization. However, such cases did not appear more often than in the production dairy farms at the same time, and probably even less, although we have not made an exact comparison. Not one case of urea poisoning was considered. All calves born were alive and remained healthy during the period in which they grew in the Experimental Unit. On the grounds of the state of health and fertility it can be concluded that there were no influences connected with the variants of the trial. The reasons (for cows being removed) from the trial were mastites, metrites, as well as infertility and low milk yield.

Neither have the blood and urine analysis shown differences between the experimental groups (Table 6).

Table 6. Results of the blood and urine analyses ($\bar{x}$ ± s)

Items	Cows received complete concentrate feed	Cows received barley meal protein feed	
		oil meal	urea
	In blood		
Hematocrit, %	41.0±2.25	42.2±1.67	40.7±2.02
Glucose, mg/dl	44.1±4.85	45.7±5.02	45.2±4.02
Protein, g/dl	7.45±0.36	7.33±0.42	7.65±0.29
Ketone bodies, mg/dl	4.71±0.28	4.93±0.30	5.24±0.32
K, mg/dl	17.83±0.52	18.09±0.46	17.33±0.58
Ca, mg/dl	10.81±0.25	11.05±0.29	10.73±0.31
Na, mg/dl	312.5±9.8	320.7±10.3	317.2±8.4
Inorganic P, mg/dl	6.51±0.53	6.24±0.65	6.82±0.70
NH_3, mM/L	0.20±0.08	0.26±0.10	0.25±0.09
	In urine		
NH_3, mM/L	4.85±1.07	5.64±2.25	8.36±3.70
Urea, %	1.61±0.72	2.53±1.25	2.80±1.03

It can be seen from the table that the urine analysis varied most largely. Thus, the urine of the cows which received urea with the feed contained considerably more ammonia than the urine of the other cows. The urea content of the urine of these cows was also higher. However, the difference between the cows of this group and the group to which barley meal with oil meal was fed was not so great as in the ammonia content.

It can be concluded that ammonia appearing in the rumen (it appears at a moderate rate in the organism of all the cows) was partly used by rumen microbes for the synthesis of their own cell protein. The other part, which the rumen microbes could not use and which was absorbed, was rapidly transformed into urea in the liver, and as a result the ammonia content of the blood remained low.

The ammonia content of the blood of the cows that obtained urea or oil meal was practically equal, 0.25 and 0.26 mM/L respectively, considerably below toxic level (0.6…0.9 mM/L, Jeroch, 1976).

On the productive farms feeding mixed concentrates containing urea, cases of toxicity sometimes appeared. However, these cannot be written into the account of urea as a protein supplement as a whole, but into the account of the mistakes made by a manufacture producing mixed concentrates as a result which the product contains significantly more urea than is allowed.

In the present trial, urea was supplied to barley meal (2.5 or 3.5 %) immediately before each feeding, it was exactly weighed for each cow and carefully mixed with barley meal in an individual feeding box. Under such conditions the possibilities of giving an overdose of urea was excluded.

KOKKUVÕTE. Lehmade proteiinitarbe rahuldamisest pikaajalises söötmiskatses. *Käesolevas artiklis on tehtud kokkuvõte omaaegse EPA põllumajandusloomade söötmise kateedri Räni katselaudas korraldatud pikaajalisest söötmiskatsest. Kokkuvõte hõlmab 200 laktatsiooni. Katselehmi söödeti individuaalselt, mida võimaldas igale lehmale betoonist valatud kõrge taga- ja külgseintega sõim.*

Katsetehnik koostas igale lehmale söödaratsiooni kord kuus, arvestades eelkõige nende metaboliseeruva energia tarvet. Ratsioonis ettenähtud söödad kaalus ta igale lehmale igal söötmiskorral, ka söödajäägid kaaluti. Samuti kaalus katsetehnik igal lüpsikorral igalt lehmalt lüpstud piima. Katselehmade piima rasvasisaldus määrati kolm korda kuus (kaks

korda katselaudas Gerberi meetodil, üks kord ELVI piimanduslaboratooriumis automaat-analüsaatoriga), piima valgusisaldus määrati üks kord kuus ELVI piimanduslaboratooriumis.

Katselehmad olid aastaringselt laudas, suvel lasti neid liikumiseks lühiajaliselt lauda juures olevasse aeda, kust saadava rohu kogus oli tühine. Talvel söödeti lehmadele heina ja rohuheksleid, põhku, kartulit ja jõusööta. Suvel asendati umbes pool kuivast rohusöödast haljassöödaga, põhku ja kartulit ei söödetud.

Katselehmi söödeti kolme, üksteisest jõusööda poolest erineva põhivariandi kohaselt: a) odrajahu + srott (OM-rühm), b) jõusöödatehases valmistatud segajõusööt lehmadele (MC-rühm), c) odrajahu + karbamiid (2,5 või 3,5 % odrajahu kogusest) (U-rühm). Põhisööta söödeti kõikidele lehmadele ühesuguse katseskeemi kohaselt.

Katse põhitulemused on toodud tabelites 1…5. Neist tulenevad alljärgnevad järeldused.

1. Kõik kolm katsevarianti tagasid praktiliselt sama hea tulemuse. Leidis kinnitust seisukoht, et Ülenurme põldudelt kogutud söötade söötmisel määrab lehmade piimatoodangu geneetiliste eelduste kõrval nende metaboliseeruva energia tarbe rahuldamine.

2. Söödaratsiooni kuivaine 13,8 %-line proteiinisisaldus näis olevat rakendatud söötmistingimustes 4500 kg laktatsioonitoodangu saamiseks küllaldane. Sellest suurem proteiinisisaldus (OM-rühmas keskmiselt 15,1 %) ei suurendanud rühma keskmist toodangut. Proteiinirikkama ratsiooni positiivne mõju avaldus küll täiskasvanud lehmade puhul, kui laktatsioonitoodang ulatus 5000 kg piirile.

3. Karbamiidiga rikastatud (2,5 resp. 3,5 %) odrajahu, mis tõstis ratsiooni kuivaine proteiinisisalduse 15,6 %-ni, osutus sama heaks kui tehases toodetud segajõusööt või srotiga segatud odrajahu.

4. Katsesöötmise variandid ei avaldanud kindlasuunalist mõju lehmade tervisele ja tiinestumisele, samuti sündinud vasikate elujõulisusele. Tervisehäired (seedekorratused, mastiit, metriit) ning ahtrus esinesid kõigis katserühmades praktiliselt ühesuguse sagedusega.

5. Proteiinirikkama sööda, eriti karbamiidi lisasöötmise korral halvenes proteiini kasutamise efektiivsus, mis avaldus eelkõige uriiniga väljutatud lämmastikuliste ainete koguse suurenemises. Karbamiidi saanud lehmade uriinis sisaldus ammoniaaki 72 % ja karbamiidi 74 % rohkem, kui seda oli segajõusöödaga söödetud lehmade uriinis. Vereseerumis oli karbamiidi rühma lehmadel ammoniaaki 25 % rohkem kui segajõusööda lehmade vereseerumis. Suurenenud ammoniaagisisaldus (0,26 mM/L) jäi aga oluliselt allapoole toksilisuse piiri (0,6…0,9 mM/L). Siit võib järeldada, et vatsast imendunud ammoniaak kõrvaldub kiiresti, see muudetakse maksas karbamiidiks, mille üleliigne kogus elimineerub uriiniga.

Sellise söötmisrežiimi puhul, nagu rakendati katselaudas, olid karbamiidimürgituse nähud välistatud. Praktikas omal ajal esinenud karbamiidimürgituse juhtumid tuleb kirjutada jõusööda karbamiidiga puuduliku saamise ja sellise jõusööda söötmise reeglite eiramise arvele.

6. Praeguses söötmisolukorras, kus srotid on ülemäära kallid, on karbamiidil kui odaval proteiinsöödal kindlasti oma koht veiste jõusööda proteiiniga rikastamisel.

Kirjandus

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Põllumajandusloomade söötmisnormid koos söötade tabelitega. – Tartu, 1995. – 186 lk.