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NUTRITION OF DAIRY COWS IN SUMMER AND NITROGEN EXCRETION

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A B S T R A C T

Nutrition and production of 200 Friesian cows, which produced 24 kg milk a day, were monitored during five summer months. In September, the amount of total non-protein and ammonia nitrogen were determined in faeces, which were taken from ten cows' recta, and in slurry. A model of regression equations, which were introduced by Kirschgessner *et al*. (1993), was used to estimate daily amount of excreted nitrogen depending on few parameters. Cows excreted on average 301 g nitrogen a day depending on average consumed dry matter, depending on average consumed nitrogen 341 g, and depending on daily amount of milk 271 g. Faeces contained 34.04 ± 1.69 g total, 6.36 ± 0.76 g non-protein and 2.07 ± 0.33 g ammonia nitrogen, slurry contained 96.77 g total, 72.22 g non-protein and 57.15 g ammonia nitrogen, all per kg of dry matter. Protein surpluses in a ration reflected in more excreted nitrogen by urine while only in traces by faeces.

Key words: cattle / cows / dairy cows / animal nutrition / summer nutrition / nitrogen / excrements

PREHRANA KRAV V POLETNI SEZONI IN IZLOČANJE DUŠIKA

I Z V L E Č E K

Pet poletnih mesecev smo spremljali prehrano in proizvodnjo 200 krav črno-bele pasme, ki so v povprečju dajale po 24 kg mleka dnevno. V mesecu septembru smo v blatu, ki smo ga rektalno odvzeli 10 kravam, in v gnojevki določili količino skupnega, nebeljakovinskega in amoniakovega dušika. Z modelom regresijskih enačb, ki jih navaja Kirchgessner s sod.(1993), smo ocenili dnevno količino z iztrebki izločenega dušika odvisno od več parametrov. Odvisno od povprečno dnevno zaužite suhe snovi so krave dnevno izločile v povprečju 301 g dušika, odvisno od povprečno zaužitega dušika 341 g in odvisno od dnevne količine mleka 271 g. Blato je vsebovalo 34,04 ± 1,69 g skupnega, 6,36 ± 0,76 g nebeljakovinskega in 2,07 ± 0,33 g amoniakovega dušika, gnojevka pa 96,77 g skupnega, 72,22 g nebeljakovinskega in 57,15 g amoniakovega dušika, vse v kg sušine. Presežki beljakovin v obroku so se odrazili v povečanem izločanju dušika s sečem, z blatom pa le neznatno.

Ključne besede: govedo / krave / molznice / prehrana živali / poletna prehrana / dušik / izločki

INTRODUCTION

Intensive production of highly productive cows could cause the pollution of the environment with nitrogen. Animals excrete more nitrogen if rations are not balanced, which often happens in practice. Not utilized nitrogen is excreted with faeces and urine, while milk contains more urea. The problem is still being studied (Fleischer, 1997; Raskin *et al.*, 1997).

Kirchgessner *et al.* (1991) and Korevaar (1991) reported that animal production represented the main source of environment pollution and especially of water. In Slovenia slurry certainly is an ecological problem. It smells, contains a lot of ammonia, pollutes water and causes the so called subterranean acid rain (Amon, 1996). Since 1996 the Regulation on Entrainment of Dangerous Matters and Plant Nutrients into Ground (UL RS, 1996) has been in force.

A cow in lactation excretes from 200 to 300 g of nitrogen by excrements (Kirchgessner, 1991). Such a wide range results from differences in production and consumption of nutrients, primarily nitrogen. In practice, higher consumption of dry matter causes increased excretion of nitrogen with excrements, on average for 19 g per kg of dry matter (Kirchgessner *et al.*, 1993).

Besides consumption of dry matter, the amount of excreted nitrogen with excrements is affected by the amount of crude protein in a ration. The result of increased amounts of protein in a ration is increased excretion of nitrogen in urine. Extra percentage of protein in a ration per kg of consumed dry matter increases excretion of nitrogen with excrements by 1.85 g (Kirchgessner *et al.*, 1991). In ruminants the usage of protein depends on the ratio of consumed proteins to energy. Protein surpluses and energy shortage are result of increased content of nitrogen, primarily of the one that is soluble in water, and decreased content of carbon in excrements. Energy surpluses and protein shortage give opposite results (Kirchgessner and Kreuzer, 1986).

In the Karst region, slurry from the farms with a larger number of animals additionally endangers the environment.

Data on meal composition, amounts and composition of milk, composition of faeces and slurry and reports by other authors (Kirchgessner *et al.*, 1993) served to estimate the excretion of nitrogen with excrements on a farm with 240 cows.

MATERIAL AND METHODS

During the pasture season (May - September) in 1997 we monitored monthly nutrition, production and composition of milk of 200 Friesian cows. Cows grazed 16 hours a day, and they were in stalls for 8 hours. In stalls they were fed by available fodder as follows (kg):

	May	**June**	**July**	**August**	**September**
Hay	4.0	4.0	3.5	3.0	4.0
Maize silage	10.0	0.0	0.0	0.0	5.0
Grass silage	0.0	10.0	10.0	10.0	10.0
Feed mixtures	3.2	3.0	3.0	3.4	4.0

Cows were housed in a modern stall. Slurry ran under the screens in the passage into the first container near the stall.

The previous year dairy cows produced on average 6,703 kg of milk with 31.7 g protein kg^{-1} and 39.5 g of fat kg^{-1}.

Towards the end of the grazing season (September 05) ten cows had the faeces taken from their recta for chemical analyses. Samples were taken from the first container in the same time. Before taking the samples slurry was mechanically homogenized.

Total non-protein (Methodenbuch, 1976) and ammonia nitrogen as well as pH values were determined in the faeces and slurry.

The multiple regression (Kirchgessner *et al*., 1993) was used to estimate the daily amounts of consumed dry matter, consumed nitrogen and produced milk per cow and month from available data.

Data were statistically processed by SAS.

Table 1. Feed composition (g kg DM^{-1})
Preglednica 1. Sestava krmil (g kg SS^{-1})

Feed Krmilo	Pasture Paša				Hay Mrva	Silage Silaža		Feed mixture Krmna mešanica	
	V.	VI.	VII.	IX.		Grass Travna	Maize Koruzna	1	2
DM - SS, g kg^{-1}	150.6	151.9	167.0	132.5	898.6	317.2	397.4	886.9	887.7
CP - SB	262.8	212.0	191.0	309.4	115.0	160.1	69.2	137.7	131.1
CF – SV	185.2	258.7	237.7	232.5	322.4	251.2	196.7	62.8	51.0
EE - SM	49.8	42.1	43.7	43.8	31.2	45.3	32.2	44.9	44.4
CA - SP	88.8	90.2	67.1	99.6	72.0	49.5	35.6	57.9	75.6
N - free extractives Brez N izvlečki	413.4	397.0	460.5	314.7	459.4	453.6	666.3	696.7	697.9

RESULTS AND DISCUSSION

Table 2 displays average consumption of nutrients per day and month, which were used for estimation of excreted nitrogen with excrements and of daily production of milk. From May to August cows consumed between 55 kg and 60 kg pasture, and in September 25 kg a day.

Table 2. Mean daily consumption of nutrients and milk production per cow
Preglednica 2. Povprečno dnevno zauživanje hranilnih snovi in prireja mleka na kravo

Month -Mesec	V.	VI.	VII.	VIII.	IX.	Average Povprečje
DM, kg - SS, kg	19.11	17.74	18.16	18.74	15.61	17.87
CP, g - SB, g	3360	3051	2955	3088	2533	2997
CP in DM, % - SB v SS, %	17.52	17.19	16.27	16.40	16.22	16.77
NEL, MJ	132.46	116.21	112.66	115.95	102.67	115.99
CP, g – SB, g : NEL, MJ	25.36:1	26.25:1	26.23:1	26.55:1	24.67:1	25.8:1
Average milk per day, kg Povprečno mleka na dan, kg	25.53	24.09	23.02	23.59	21.83	23.61

Table 2 shows that cows consumed too many protein during the season regarding the achieved production (DLG, 1991). Dairy cows excrete about 80 % of consumed nitrogen with faeces and urine (Montard, 1977). Our cows excreted with excrements more nitrogen as they should with balanced rations (Table 4).

Unbalanced rations resulted in higher concentration of urea in milk, which is shown in Table 3. Analyses of rations showed that increased content of urea in milk during all months is the result of surpluses of protein, except in September when there was a shortage of energy in rations. Increased content of urea in milk demonstrated that much of consumed proteins were lost. The composition of milk is a good indicator of increased excretion of nitrogen.

Table 3. Mean content of dry matter, protein and urea in milk samples from basin (n=10)
Preglednica 3. Povprečna vsebnost suhe snovi, beljakovin in sečnine v vzorcih mleka iz bazena(n = 10).

Milk components Sestavine mleka Month - Mesec	Date of taking sample Datum odvzema vzorca	Dry matter Suha snov g kg^{-1}	Protein Beljakovine g kg^{-1}	Urea Sečnina mmol l^{-1}
May Maj	12.05 23.05. Mean -Sredina	124.4 122.3 123.4	33.0 32.3 32.7	5.25 4.77 5.01
June Junij	09.06 19.06 Mean - Sredina	121.1 121.6 121.4	31.6 31.9 31.8	5.03 4.67 4.85
July Julij	09.07. 29.07. Mean - Sredina	121.3 121.8 121.6	31.0 31.4 31.2	5.17 6.14 5.66
August Avgust	05.08 29.08 Mean - Sredina	122.7 122.0 122.4	32.5 32.0 32.3	7.49 8.14 7.82
September September	09.09. 24.09 Mean - Sredina	122.8 126.3 124.5	31.8 33.4 32.6	7.30 5.81 6.56
Mean - Sredina		122.6	32.1	5.98
Median - Mediana		122.2	32.0	5.53
Minimum -Najmanj		121.1	31.0	4.67
Maximum -Največ		126.3	33.4	8.14
SD -SO		1.6	0.7	1.25
SE - SN		1.1	0.6	1.03
CV, % - KV, %		13.0	22.7	20.88

The average daily amounts of excreted nitrogen with excrements (faeces and urine) per month depending on various parameters (Kirchgessner *et al.*, 1986) were estimated by regression and are shown in Table 4.

Table 4. Mean excreted nitrogen (g) per day and cow
Preglednica 4. Povprečno izločen dušik (g) na dan in kravo

Month Mesec	V.	VI.	VII.	VIII.	IX.	Average Povprečje
In dependence on Odvisno od:						
-consumed DM, kg - zaužite SS, kg	325	299	307	318	258	301
- consumed N, g - zaužitega N, g	382	347	336	351	288	341
- quantity of milk, kg - količine mleka, kg	285	275	267	271	259	271
- per kg of milk - na kg mleka	15.25	15.07	13.77	13.82	14.09	14.4

Table 4 indicates that there are notable differences among estimations of excreted nitrogen depending on few parameters. The estimation of excreted nitrogen with excrements depending on produced milk, which was 271 g per cow and day, approached the referred reports the most, following by the amount of excreted nitrogen depending on consumed dry matter, which was 301 g per cow and day. These amounts are in accordance with the reported amounts being 304 g of excreted nitrogen per cow and day for particularly grassy regions (Ruppert *et al*., 1985). The most exceeded the estimation on the base of consumed nitrogen, which was on average 341 g per cow and day and testified significant surpluses of proteins as well as too wide ratio of protein to energy in rations. Furthermore poor energy supply in June, July and at the beginning of September affected poor usage of consumed protein, which was manifested in milk composition (Table 3). With the average daily milk production of 23.61 kg per season the ratio of consumed protein (g CP) to net energy for lactation (MJ NEL) was of 25.8 to 1, and wider in June, July and August. Jilg (1992) reported the average daily production 25 kg of milk and the ratio of 22.6 to 1. Nevertheless, by intensive cultivation of pastures and the used technology of grazing on the studied farm the protein surpluses during the season cannot be avoided.

In our previous studies the cows on the farm A excreted 294 g of nitrogen a day depending on the amounts of consumed dry matter, 313 g depending on consumed nitrogen and 309 g of nitrogen a day depending on the daily amount of milk, using the same model, and producing 5,740 kg of milk a year and having more balanced summer rations (g CB : MJ NEL = 23.5 : 1) (Rajčevič *et al*., 1994 a; Rajčevič *et al*., 1994 b). On the farm B, where the yearly production was 7,190 kg of milk, we estimated excretion of nitrogen for winter and summer season apart and for the whole year. Rations were more balanced. During the year, cows excreted with excrements 309 g of nitrogen depending on consumed dry matter, 310 g depending on consumed nitrogen and 209 g depending on daily amount of produced milk. The summer season was a bit worse. The ratio of protein to energy was of 24.6 to 1. Cows excreted with excrements 326 g of nitrogen a day depending on daily amount of consumed nitrogen (Rajčevič and Vardjan, 1995; Rajčevič and Vardjan, 1996).

Preglednica 5. Povprečna količina skupnega, amoniakovega in nebeljakovinskega dušika v SS ter pH vrednost v blatu (n=10)

Table 5. Mean quantity of total, ammonia and nonprotein nitrogen in DM and pH value of feaces (n = 10)

Faeces' parameters Parametri blata	Dry matter Suha snov g kg^{-1}	Total nitrogen Skupni dušik g	NH_3-N g	NPN-N g	pH
Mean - Sredina	129.28	34.04	2.07	6.36	6.97
Median - Mediana	127.70	34.25	2.17	6.45	6.95
SD - SO	11.32	1.07	0.33	0.76	0.14
SE - SN	9.44	1.26	0.28	0.62	0.13
CV, % - KV, %	9.33	4.70	16.06	12.01	2.02
Minimum - Najmanj	113.70	29.83	1.46	5.15	6.80
Maximum - Največ	152.70	36.21	2.54	7.88	7.21

It is evident from Table 5 that faeces contained in the dry matter 34.04 g of total nitrogen, 6.36 g of non-protein nitrogen and 2.07 g of ammonia nitrogen, the pH value being 6.97. Spickers and Pfeffer (1991) reported that dairy cows fed by balanced rations excreted 32 g of nitrogen kg DM^{-1}. In balance experiments of Kirchgessner and Kreuzer (1986) dairy cows fed by balanced rations excreted 233 g ± 28 g of nitrogen a day, 59 % with faeces and 41 % with urine. At 25 % protein surplus in rations cows excreted 311 g ± 38 g of nitrogen a day, which was by

33 % more. The ratio of nitrogen in faeces to urine was of 50 to 50. The studied cows consumed 19 % of nitrogen more considering the daily amount of produced milk, the estimation with regression showed 25 % more of excreted nitrogen.

Leskošek and Lobnik (1987) reported that summer undiluted slurry contained 9 % of dry matter, and in a ton of slurry (m^3) there was 5.1 kg of nitrogen in Slovenia. Kocijančič (1988) reported that slurry from the studied farm contained 7.8 % of dry matter and 0.2 % of nitrogen in summer. Kirschgessner *et al*. (1991) reported that slurry contained 0.53 ± 0.06 % of nitrogen in balanced rations, but the amount of nitrogen increased significantly by 0.037 % for each percentage of protein if the content of protein in rations increased, and by 0.05 % for each kg of milk if milk production increased.

In the slurry there were 96.77 g nitrogen kg^{-1} DM. Nearly half of it was in the form of ammonia, which was in accordance with the reports of Kokalj *et al.* (1983). There were 72.22 g of non-protein nitrogen. The amount of determined nitrogen in faeces and slurry showed that cows excreted most of the consumed surpluses of nitrogen with urine. We are of the opinion that such a high amount of excreted nitrogen in urine was the result of unappropriate source of carbohydrates (Raskin *et al*., 1997). We have to consider that the excretion of urine increases in summer and nearly half of the nutrients excreted by excrements remains on the pasture (Kocjančič, 1988).

Near the studied farm there are several containers for slurry and several watter springs. According to data on influence of slurry on watter of Institute for Health Care Ljubljana, which analysed 22 water springs in 1996 (two repetitions: March 7 and April 4), the lowest amount of nitrates in water was 0.002 mgl^{-1}.

CONCLUSION

Despite the fact that feed mixtures were added to pasture, rations were not balanced enough. It is estimated that cows over excreted on average 25 % of nitrogen considering the daily amount of produced milk. We think that such an increase could be the result of unappropriate source of carbohydrates in the feed mixtures. Cows excreted most of the nitrogen surpluses with urine.

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