Taylor & Francis
Taylor & Francis Group

Italian Journal of Animal Science

ISSN: (Print) 1828-051X (Online) Journal homepage: http://www.tandfonline.com/loi/tjas20

Effects of constant vs variable dietary protein content on milk production and N utilization in dairy cows

Gianni Matteo Crovetto, Stefania Colombini, Gianni Colombari & Luca Rapetti

To cite this article: Gianni Matteo Crovetto, Stefania Colombini, Gianni Colombari & Luca Rapetti (2009) Effects of constant vs variable dietary protein content on milk production and N utilization in dairy cows, Italian Journal of Animal Science, 8:sup2, 292-294, DOI: 10.4081/ijas.2009.s2.292

To link to this article: https://doi.org/10.4081/ijas.2009.s2.292

Published online: 07 Mar 2016.

Effects of constant *vs* variable dietary protein content on milk production and N utilization in dairy cows

Gianni Matteo Crovetto[1], Stefania Colombini[1], Gianni Colombari[2], Luca Rapetti[1]

[1]Dipartimento di Scienze Animali, Università di Milano, Italy

[2]ERSAF, Mantova, Italy

Corresponding author: Gianni Matteo Crovetto. Dipartimento di Scienze Animali, Sezione di Zootecnica Agraria, Università degli Studi di Milano. Via Celoria 2, 20133 Milano, Italy – Tel. +39 02 50316433 – Fax: +39 02 50316434 – Email: matteo.crovetto@unimi.it

ABSTRACT - Forty-two lactating Holstein cows were divided into two groups, control (C) and test (T), and used in a cross-over design. In each group cows were also divided in three subgroups on the basis of milk yield: low (L), medium (M) and high (H). C cows were fed a diet with 15.4% CP on DM. T cows were fed three diets with the CP content (% DM) adjusted to milk yield (13.6, 15.2 and 17.2 for diets TL, TM and TH). At the highest level of production TH diet improved milk yield (kg/d) (38.9 C *vs* 41.0 TH) and FCM (kg/d) (39.6 C *vs* 40.6 TH) (P<0.05). No differences were detected for TL and TM diets compared to C. For L and H subgroups milk urea (mg/dl) was increased by the higher CP diets (28 C *vs* 24 TL; 30 C *vs* 36 TH; P<0.05). N efficiency (milk N, %N intake) was higher with lower CP diets (22 C *vs* 25 TL; 32 C *vs* 29 TH) and for increased milk yield. An adequate CP content of the diet enhances milk production in high yielding dairy cows, but an excessive amount of dietary N increases milk urea and N excretion.

Key words: CP level, Milk production, N excretion.

Introduction - As herd production levels continue to improve along with herd size and genetic merit, meeting the nutritional needs of the lactating dairy cows is an increasing challenge for modern dairy producers. One of the most effective ways to meet nutrient requirements of dairy cows is to feed and manage them in groups depending on productive level and stage of lactation (early, mid and late). For example crude protein (CP) requirements during mid lactation are lower than in early lactation (NRC, 2001) and overfeeding CP reduces profit margins because of the relatively high cost of protein supplements and the poor efficiency of N use by dairy cows fed high protein diets (Broderick, 2003). In our condition, especially for small-medium size herd, a unique ration is often fed to all lactating cows independently from milk yield. This results in higher incidence of metabolic disorders, higher costs and environment pollution due to an increment in N excretion. The aim of this study was to determine, in dairy cows with a different milk yield, the optimum CP content of the diet required to maximize production of milk at minimal N excretion.

Material and methods – Forty-two lactating Holstein cows were divided into two groups, control (C) and test (T) and used in a cross-over design. Cows were blocked by parity, DIM and milk yield. In each group cows were also divided in three subgroups on the basis of the stage of lactation and milk yield (kg/d): low (L≤25), medium (M 25<yield≤35) and high (H>35). All the cows of group C were fed a control diet with 15.4% CP on DM. Cows of group T were fed, depending on their milk yield, three diets with 13.6, 15.2 and 17.2% CP on DM (table 1).

Each experimental period lasted 21 d (14 of adaptation and 7 of sample collection). Individual milk yield was measured daily and individual milk daily samples were analysed for fat, protein and urea. N balance was calculated from the observed dry matter intake of each group, average milk yield and milk protein content. N excreted with faeces and urines was predicted by the Cornell Penn Miner software (CPM, 2004). Milk urea nitrogen was also predicted by CPM.

Data were analysed using Proc GLM procedures by SAS (SAS Institute, 2000) with the following model:

$Y_{ijklm} = \mu + T_i + A_j (G_k) + P_l + (TxG)_{ik} + e_{ijklm}$

where T_i= 1-2 treatment (C *vs* TL, C *vs* TM, C *vs* TH); A_j = 1-14 (animal within group); G_k = 1-3 (group: L, M, H); P_l = 1-2 (period: 1 e 2); e_{ijklm} = residual error. The data in the tables are presented as least-square means (LSM) ±standard error of the mean.

Table 1. Composition and chemical analysis of the experimental diets

		C	TL	TM	TH
Corn silage	(kg/d)	18.0	18.0	18.0	18.0
Alfalfa hay	(kg/d)	5.5	5.5	5.5	5.5
Italian ryegrass hay	(kg/d)	2.6	2.6	2.6	2.6
Corn meal	(kg/d)	4.3	2.9	3.8	5.1
Barley meal	(kg/d)	1.4	1.0	1.3	1.7
Soybean meal	(kg/d)	2.8	1.4	2.6	3.4
Soybean flakes	(kg/d)	-	-	-	1.3
Min/vit. suppl.	(kg/d)	0.4	0.3	0.4	0.5
Crude protein	(% DM)	15.4	13.6	15.2	17.2
Soluble protein	(% CP)	31.6	36.4	32.2	31.3
aNDFom[1]	(% DM)	34.3	37.7	34.9	31.5
ADFom[2]	(% DM)	23.4	26.1	24.0	21.3
ADLom[2]	(% DM)	4.0	4.6	4.1	3.6
Starch	(% DM)	27.3	25.6	26.7	27.4
NE_l	(MJ/kg DM)	6.61	6.40	6.54	6.97

[1]NDF assayed with a heat stable amylase and expressed exclusive of residual ash; [2]expressed exclusive of residual ash.

Results and conclusions – As expected DMI was positively correlated to milk yield (r=0.89) (table 2). At the high level of production T diet (TH) improved significantly milk and FCM yields (P<0.05), whereas no significant differences were detected for TL and TM diets compared to C (table 2). For low yielding dairy cows a CP content of 13.6% on DM was adequate to support a milk yield of approximately 20 kg/d even if protein yield was significantly lower for diet TL (812 *vs* 777 g/d for C and TL; P<0.05). It must be also underlined that the CP content of diet TH was 17.2% on DM and slightly higher than the value (16.5%) recommended for lactating dairy cows (Olmos Colmenero and Broderick, 2006). Other studies have also reported no improvement in milk and protein productions when dietary CP was increased from 16.1–16.7% to 18.4–18.9% on DM (Cunningham *et al.*, 1996; Broderick, 2003; Leonardi *et al.*, 2003). For L and H subgroups milk urea was increased by the higher CP diets (P<0.05) (table 2). Milk urea was positively correlated to dietary CP content (r=0.93) as found in previous studies (Nousiainen *et al.,* 2004; Olmos Colmenero and Broderick, 2006). A good correlation was found also between milk urea and the ratio of dietary CP to energy (r=0.93) in agreement with Oltner and Wiktorsson (1983). Milk urea predicted values were also highly correlated with the observed concentrations (r=0.95). In the present study the content of milk urea (36 mg/dl) of cows fed TH diet (CP 17.2%) was quite high indicating an inefficient use of dietary CP. Colmenero and Broderick (2006) reported a milk urea content of 27.8 mg/dl for a diet with a CP content of 17.9%. In the latter study the non fibrous carbohydrate (NFC) content of the diet was much higher than that of our study (50 vs 40% on DM) and this results in a better utilization of N, especially NH_3-N, at rumen level.

Considering the N balance (table 2), N efficiency (milk N, % of N intake) within each subgroup was always higher with lower CP diets. Consistently with literature (Flachowsky and Lebzien, 2006) N efficiency was higher for increased milk yields (on average 23.5, 27.0 and 30.5% respectively for L, M and H subgroups). The proportion of N excreted with urine increased with higher dietary CP content (27-31-35% for TL, TM, TH) and, for the unique C diet, with lower milk yields (37-32-27% for CL, CM, CH). In conclusion, the data obtained indicate that an adequate CP content of the diet enhances milk production in high yielding lactating cows, but an excessive amount of dietary N, if not properly balanced with NFC, increases milk urea N and N excretion.

Table 2. Dry matter intake (DMI), milk yield and quality and nitrogen balance of low (L), medium (M) and high (H) yielding cows fed the control (C) and test (T) diets.

Subgroup		L			M			H		
Diet		C	TL	SEM	C	TM	SEM	C	TH	SEM
DMI		22.9	21.7		23.4	23.2		23.9	24.9	
Milk	kg/d	19.9	19.2	0.38	26	25.9	0.39	38.9[b]	41.0[a]	0.36
FCM 4%	kg/d	22.8	22.1	0.36	28.5	28.5	0.39	39.6[b]	40.6[a]	0.36
Fat	%	4.80	4.84	0.042	4.50	4.51	0.043	4.01[a]	3.83[b]	0.040
Protein	%	3.99	3.95	0.012	3.75[a]	3.71[b]	0.012	3.11	3.13	0.011
Urea determined	(mg/dl)	28a	24[b]	1.2	30	32	1.6	30[b]	36[a]	1.3
Urea predicted	(mg/dl)	28	20		28	28		28	35	
N intake	(g/d)	565	473		578	566		588	686	
Milk N	(% N intake)	22	25		27	27		32	29	
N urine	(% N intake)	37	27		32	31		27	35	
N faeces	(% N intake)	41	48		41	42		41	36	

[a b]*within each subgroup means that are followed by different letter are significantly different (P<0.05).*

The research was supported by Regione Lombardia, project BIAZO.

REFERENCES - Broderick, G. A., 2003. Effects of varying dietary protein and energy levels on the production of lactating dairy cows. J. Dairy Sci. 86:1370–1381. **CPM, Cornell-Penn-Miner**, 2004. CPM Dairy. Dairy cattle ration analyzer, version 3.0.6. **Cunningham**, K. D., Cecava, M.D., Johnson, T.R., Ludden, P.A., 1996. Influence of source and amount of dietary protein on milk yield by cows in early lactation. J. Dairy Sci. 79:620–630. **Flachowsky**, G. and Lebzien, P., 2006. Possibilities for reduction of Nitrogen (N) excretion from ruminants and the need for further research – a review. Landbauforschung Völkenrode 56:19-30. **Leonardi**, C., Stevenson, M., Armentano, L.E., 2003. Effect of two levels of crude protein and methionine supplementation on performance of dairy cows. J. Dairy Sci. 86:4033–4042. **National Research Council**, 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC. **Nousiainen**, J., Shingfield, K.J., Huhtanen, P., 2004. Evaluation of milk urea nitrogen as a diagnostic of protein feeding. J. Dairy Sci. 87: 386-398. **Olmos Colmenero** J. J. and Broderick, G.A., 2006. Effect of dietary crude protein concentration on milk production and nitrogen utilization in lactating dairy cows. J. Dairy Sci. 89:1704–1712. **Oltner**, R. and Wiktorsson, H., 1983. Urea concentrations in milk and blood as influenced by feeding varying amounts of protein and energy to dairy cows. Livest. Prod. Sci. 10:457. **SAS**., 2000. User's Guide: Statistics, version 6.SAS Institute Inc., Cary, NC, USA.