Can we motivate dairy cows to increase their grass intake by feeding low protein supplements?

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Abstract

Literature shows that ruminants are able to balance their protein intake to meet their requirements. It would be interesting to know if this also applies to grazing dairy cattle. Our question was: Can we motivate grazing dairy cows to increase their intake of protein-rich grass by supplementing them with low protein concentrates? Sixty Holstein-Friesian dairy cows were allocated to two grazing systems (compartmented continuous grazing vs strip grazing), and two levels of protein supplementation Low (LP) vs High (HP). Treatment LP and HP received 5.5 kg DM concentrate cow^{-1} d^{-1}, which were different in rumen-degradable protein balance (OEB) (-57 vs +56 OEB kg DM^{-1}), but were equal in intestinal digestible protein (DVE) and net energy content. The cows grazed during the day and received 7 kg DM cow^{-1} d^{-1} maize silage indoors. During three periods, individual milk performance, total and grass DMI were measured. Grass DMI was not different between the treatments, total DMI was significantly lower in LP. This was due to a lower voluntary intake of maize silage. The reduced total DMI and nutrient intake explains the reduced milk and protein yield in LP. Feeding low protein concentrate is not a successful strategy to increase grass DMI.

Keywords: dairy cows, protein, grass intake

Introduction

Dairy cows given a free choice between silage based diets different in rumen degradable protein (RDP), selected a diet with sufficient RDP avoiding excess RDP diets (Tolkamp *et al*., 1998). Scott and Provenza (2000) found that lambs challenged by imbalances in dietary energy or protein, select foods and foraging locations to correct these imbalances. These findings raised the following questions: Does this also apply to grazing dairy cows and can we motivate dairy cows to increase their grass intake by feeding low protein supplements? The idea was that cows when kept indoors during the night and supplemented with maize silage and a concentrate low in RDP would be challenged with a (temporary) shortage of RDP. The cows can overcome this shortage of RDP through an increased intake of grass, which is usually high in RDP. If this mechanism works, this strategy could be implemented on the majority of dairy farms in the Netherlands, as most of the farmers practice a part-time grazing system with supplemental feeding indoors. In order to test the hypothesis, an experiment was carried out to study the effect of level of RDP supplementation on grass dry matter intake (GDMI) and milk production of dairy cows grazing during the day and housed during the night. In order to broaden the scope, this was done with two contrasting grazing systems which cover the most common grazing practices in the Netherlands.

Materials and methods

The experiment was carried out from 25 April to 27 October 2017 at Dairy Campus, the Netherlands (53°10 N, 5°45 E). Sixty Holstein-Friesian (HF) spring calving dairy cows were assigned to 15 blocks based on parity, days in milk, milk constituent yield, fat and protein corrected milk yield (FPCM) and body weight. The experiment involved two grazing systems (GS): comparted continuous grazing (CCG; an adapted set-stocking system in which the cows rotate on a daily basis between six compartments in one paddock) and strip grazing (SG) (see Holshof *et al.* (2018) for a detailed description of the grazing systems) and two levels of RDP (high; HP and low; LP) in a 2 × 2 factorial design, creating four experimental groups CCG-HP, CCG-LP, SG-HP and SG-LP. Within blocks, cows were randomly allocated to one of the four treatment groups. A difference in RDP between HP and LP was created by supplementing the cows with 5.5 kg DM d^{-1} of concentrate different in rumen-degradable protein balance (OEB, CVB (2012)) (-57 vs +56 g OEB kg DM^{-1}). The concentrates were equal in intestinal digestible protein (DVE CVB (2012); 117g kg DM^{-1}) and net energy content 7.8 MJ NEL kg DM^{-1}. The cows were milked at 05:00 h and 17:00 h and had access to pasture from 9:00 h to 16:00 h. During the remainder of the day the cows were indoors and were individually fed maize silage using transponder controlled weighing troughs (Insentec, Marknesse, NL). Intakes of concentrates and maize silage were recorded daily. Milk yields were recorded each milking; milk fat, protein and urea were recorded weekly during four consecutive milkings. During three experimental periods in June (Jn), July (Jl) and September (Sp), individual grass dry matter intake (GDMI) was determined using the *n*-alkane technique. During a 14-day dosing period, the cows were dosed twice daily with 0.45 kg of a concentrate containing 922 mg kg^{-1} C32 n-alkane, at each milking. From day seven to 14 of the alkane dosing period the herbage, maize silage and concentrates were sampled daily and pooled by treatment for the whole sampling period. During day seven to 14 of the dosing period, faecal samples were collected from each cow twice daily after each milking. The faeces samples were pooled into one sample for each cow. The concentrations of *n*-alkanes in feeds and faeces was analysed according to the procedures described by Abrahamse *et al.* (2009). On day six and seven, of the experimental period Jl and Sp, rumen fluid samples were collected by oesophageal sampling across four time points (4:00, 12:00, 15:00 and 21:00 h). The rumen fluid samples were analysed for the NH_3 concentration according to Riede *et al.* (2013). Concentrates, grass and maize silage were analysed for chemical composition and feeding value at Eurofins Agro (Wageningen, NL). A mixed model with repeated measurements was used to analyse the effect of the treatments on weekly mean milk performance, total DMI, GDMI, with protein treatment, grazing system and period as fixed effects and block and cow as random effects.

Results and discussion

The data on TDMI, GDMI, protein intake and milk performance are presented in Table 1. There was a significant P × RDP × GS interaction, indicating that GDMI changes differently during the grazing season. This can be explained by stage of lactation and the seasonal effects on grass allowance and composition. There was a significant RDP and GS effect on TDMI. Cows on the low RDP had larger refusals of maize silage than cows receiving a high RDP levels. This suggests that cows indeed seem to balance their RDP intake albeit, in this study, not through a higher intake of grass but due to a reduction of the voluntary intake of maize silage. Because the cows were supplemented with fixed amounts of maize silage, it is not possible to draw firm statistically substantiated conclusions. Supplementation with low RDP concentrate resulted in a reduced milk and milk constituent yield. Reduced milk yield can be explained by a reduced TMDI and hence, a reduced nutrient intake. Milk urea concentrations were lower than predicted on the basis of DVE and OEB balances (Schepers and Meijer, 1998). This was confirmed by low rumen NH_3 concentrations (2.63, 2.15, 1.84 and 1.35 mmol l^{-1} for CCG-HP, SG-HP, CCG-LP and SG-LP, respectively) indicating a shortage of RDP in LP and HP as well. The reason for this observation is unclear and requires further research.

Conclusion

We did not succeed in motivating cows to increase their grass intake by feeding low protein supplement grass.

Acknowledgements

The project was funded 50/50 by PPC Feed4foodure and Melkveefonds.

Table 1. Animal performance, predicted means of daily total dry matter intake (TDMI), grass dry matter intake, net energy, intestinal digestible protein (DVE), rumen degradable protein (RDP) balance (OEB), and milk and milk constituents yield with two grazing systems (GS) comparted continuous grazing (CCG) and strip grazing (SG) and two treatments with a high (HP) and low (LP) level of RDP across three experimental periods (P).

		CCG		SG		lsd	P	GS	RDP	GS×RDP	P×GS×RDP
		HP	LP	HP	LP						
GDMI	Ju	7.0	6.5	5.5	6.0	0.69	<0.001	0.654	0.508	0.437	<0.001
($kg.d^{-1}$)	Jl	4.1	4.1	4.6	4.9						
	Sp	2.9	3.3	3.5	3.8						
TDMI	Ju	19.9	19.0	19.5	18.8	1.08	<0.001	0.015	<0.001	0.945	0.555
($kg.d^{-1}$)	Jl	19.4	18.6	20.5	18.3						
	Sp	18.3	18.0	18.9	17.5						
NEL intake	Ju	151	141	142	135	7.14	<0.001	0.042	0.002	0.226	0.132
($MJ.d^{-1}$)	Jl	134	128	132	127						
	Sp	133	127	133	124						
DVE intake	Ju	1,782	1,599	1,648	1,566	78.4	<0.001	0.164	<0.001	0.451	0.136
($g.d^{-1}$)	Jl	1,606	1,513	1,614	1,550						
	Sp	1,550	1,505	1,565	1,486						
OEB intake	Ju	308	-419	213	-363	58.2	<0.001	0.348	<0.001	<0.001	0.002
($g.d^{-1}$)	Jl	233	-379	312	-274						
	Sp	194	-300	209	-311						
Milk yield	Ju	34.3	29.6	33.6	28.4	2.47	<0.001	0.740	<0.001	0.888	0.953
($kg.d^{-1}$)	Jl	30.7	25.7	30.9	25.8						
	Sp	29.0	25.0	29.3	25.4						
Fat	Ju	1.28	1.16	1.22	1.11	0.11	<0.001	0.44	<0.001	0.675	0.599
($g.d^{-1}$)	Jl	1.12	1.05	1.09	1.01						
	Sp	0.89	0.98	0.93	0.96						
Protein	Ju	1.19	1.04	1.14	0.98	0.08	<0.001	0.269	<0.001	0.226	0.826
($g.d^{-1}$)	Jl	1.08	0.94	1.05	0.91						
	Sp	0.96	0.91	0.97	0.90						
Urea	Ju	12	7	9	5	2.5	<0.001	0.122	<0.001	0.698	0.698
($mg.100\ ml^{-1}$)	Jl	13	8	14	10						
	Sp	11	8	11	6						

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