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EFFECT OF FEEDING THE GRASS FIBROUS FRACTION OBTAINED FROM BIOREFINERY ON N AND P UTILISATION OF DAIRY COWS

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INTRODUCTION

Biomass produced by intensively managed dairy grasslands on peat soils generally contains higher amounts of N and P than biomass from mineral soils, due to the relative high organic matter mineralisation under oxic soil conditions. Consequently, if these higher amounts are not compensated for in the ration by adding lower N and P feed components, dairy cows receive a dietary surplus of N and P which in turn leads to higher on farm N and P surpluses compared to farms on mineral soils (De Visser et al., 2001). Biorefinery can split grass biomass into a fibrous fraction with lower N and P concentrations, and a fraction with higher N and P concentrations. We hypothesised that substituting part of the grass silage by an ensiled grass fibrous fraction would not affect milk production but could improve cow N and P efficiency in a grass based dairy ration with a dietary surplus of N and P, which is a common situation in a dairy farming system on a peat soil.

MATERIAL AND METHODS

On the 1st of August 2017, one half of a dairy grassland near Lelystad (the Netherlands) was harvested "conventionally" by mowing, tedding, raking and ensiling within a period of about 48h. Between 20 July and 14 August 2017, the other half of the dairy grassland biomass was refined into a N and P concentrated fraction and a fibrous fraction using a mobile installation with a refiner (GRASSA! BV, the Netherlands, 2nd prototype) followed by a screw-press (Keydollar, the Netherlands). The obtained fibrous fraction was directly ensiled. Average N and P concentrations in unrefined ensiled grass and the ensiled fibrous fraction were 37.3 vs. 29.4 and 2.8 vs. 1.9 g kg^{-1} dry matter (DM), respectively.

In autumn 2017, a feed experiment was carried out to compare the effect of unrefined ensiled grass to the ensiled fibrous fraction of refined grass on dairy cow performance and N and P balance. The experiment was set up as a 2 x 2 Latin square, consisting of two dietary treatments (unrefined grass silage, UGS and grass fibrous fraction silage, GFS) and two experimental periods of 14 days each. Eight multiparous Holstein Frisian dairy cows were evenly assigned to each dietary treatment based on lactation number and stage. Cows in the UGS treatment received 13.0 kg DM grass silage per day, while cows in the GFS treatment received 8.0 kg DM of grass fibrous fraction silage in exchange for unrefined grass silage. Both diets were equally supplemented with 8.6 kg DM of concentrates. Average crude protein and P contents of the diets were 210 vs. 190 g kg DM^{-1} and 3.3 vs. 3.0 g kg DM^{-1}, respectively for treatments UGS and GFS. Diets were formulated to meet or exceed daily energy, protein and macro-mineral requirements for dairy cows (CVB, 2016).

Cows feed intake and milk production were monitored daily. During the last three days of each experimental period, feed, milk, spot faeces and spot urine samples were collected. Feed and faeces samples were analysed for DM, crude ash, acid-insoluble ash (HCl-ash), N and P content. Milk samples were analysed for protein, fat, N and P content. Fat and protein corrected milk (FPCM) was calculated as 0.337 + 0,116 x fat percentage + 0,06 x protein percentage x kg milk production day^{-1}. Urine samples were analysed for N, P and creatinine content. Dietary digestibility of N was determined by the HCl-ash in feed and faeces (Sales and Janssens, 2003). Total urine output was estimated assuming a fixed daily urinary creatinine excretion (De Boer et al., 2002). Differences between input and output of N and P were assumed to be a result of retention and other losses than accounted for. Data was analysed by ANOVA using R (version 3.4.0, R core team, 2017).

RESULTS AND DISCUSSION

Cows in the GFS treatment had a significant lower total feed intake (*P*=0.011) compared to the UGS treatment (Table 1). The difference tended to be greater in the first compared to the second period (*P*=0.051). Cows in the GFS treatment had a significant lower daily N intake (*P*<0.001) and difference between N input and output (*P*=0.021), and tended to excrete less N via urine (*P*=0.061) compared to the UGS treatment. Furthermore, cows in the GFS treatment had a significant lower daily P intake (*P*<0.001) and faecal P excretion (*P*=0.008), and tended to have a lower daily difference between P input and output (*P*=0.089) compared to the UGS treatment. Finally, the percentage of dietary N and P excreted via milk was significantly higher for cows in the GFS treatment compared to the UGS treatment (*P*=0.006 and *P*=0.001, respectively). Since cows fed the GFS diet did not produce less FPCM but had a lower feed intake, it appeared that cows utilised the grass fibrous fraction more efficiently than the unrefined grass silage, although FCE was not significantly higher for the GFS treatment (*P*=0.304). The significant lower N input and output difference, and tendency towards a significant lower P input and output difference for cows in the GFS treatment may have been a result of a higher daily dietary N and P surpluses, resulting in higher N and P body retentions of cows (Valk and Šebek, 1999).

Table 1. Feed intake, milk production and daily N and P balances of multiparous dairy cows fed a diet based on unrefined grass silage (UGS) versus cows fed a diet of which part of the grass silage is replaced by a grass fibrous fraction (GFS).

		Treatment		*P*-values		
Parameter	Unit	UGS	GFS	Treatment (T)	Period (P)	T x P
Total dry matter feed intake	kg cow^{-1} day^{-1}	21.5	20.0	0.011	0.697	0.051
Fat and protein corrected milk	kg cow^{-1} day^{-1}	30.7	30.3	0.801	0.475	0.541
Feed conversion efficiency	kg feed kg $milk^{-1}$	1.39	1.49	0.304	0.979	0.320
N Intake	g cow^{-1} day^{-1}	721	605	<0.001	0.026	0.410
Faecal N excretion	g cow^{-1} day^{-1}	174	163	0.311	0.534	0.241
Milk N excretion	g cow^{-1} day^{-1}	162	162	0.970	0.846	0.735
Urine N excretion	g cow^{-1} day^{-1}	267	227	0.061	0.196	0.566
N input minus output	g cow^{-1} day^{-1}	117	52	0.021	0.742	0.525
P Intake	g cow^{-1} day^{-1}	71.0	60.4	<0.001	0.145	0.168
Faecal P excretion	g cow^{-1} day^{-1}	30.6	23.7	0.008	0.992	0.374
Milk P excretion	g cow^{-1} day^{-1}	28.4	28.0	0.783	0.666	0.521
Urine P excretion	g cow^{-1} day^{-1}	0.25	0.24	0.902	0.655	0.975
P input minus output	g cow^{-1} day^{-1}	11.7	8.5	0.089	0.434	0.389
Feed-N to milk-N	%	22.6	26.8	0.006	0.349	0.566
Feed-P to milk-P	%	40.0	46.4	0.001	0.429	0.527

CONCLUSION

The fibrous fraction of grass obtained from biorefinery, being less concentrated in N and P than unrefined grass silage, improved dairy cow dietary N and P utilisation without affecting milk production. Biorefinery could be used as tool to reduce environmental N and P loads of dairy farms, especially in situations where diets are grass based and grass biomass is relatively rich in N and P, such as in a dairy farming system on peat soils.

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