Effects of days of regrowth and N fertilization on fatty acid composition of perennial ryegrass and CLA concentration in milk from stall-fed dairy cows

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Abstract

Grassland management could offer means to produce milk with naturally higher concentrations of unsaturated fatty acids (FA) such as conjugated linoleic acid (CLA). Regrowth stage and N fertilization affect the concentration of FA in grasses, which could affect milk FA. Four paddocks were split and received either 73 or 37 kg N ha^{-1}; herbage was subsequently cut daily from 25 to 43 days of regrowth. Two groups of 18 cows were stall-fed during these 19 days with either high or low N fertilized grass. FA concentrations in the herbage and the CLA concentration in the milk were monitored.
The high N fertilized plots had a higher herbage mass, but there was no difference in herbage N or FA concentration. There was a negative effect of days of regrowth on the FA concentration in grass, which was associated with a lower CLA concentration in the milk. In general there was no effect of N treatment on milk CLA concentration. Only during the last two days of the experiment, when there was a very large difference in herbage mass between the N treatments (2000 *vs.* 4000 kg DM ha^{-1}), the CLA concentration was significantly ($P <$ 0.05) higher in milk of cows fed grass from the low N treatment. This could be a result of the lower herbage yield and NDF content.
The lack of effect of N fertilizer treatment on milk FA composition may be due to the fact that treatments surprisingly did not differ in grass N content. During the final days, effects were confounded with changes in other chemical composition variables. The negative effect of grass regrowth stage on herbage FA and milk CLA concentration confirmed our hypotheses.

Keywords: conjugated linoleic acid, CLA, regrowth, nitrogen

Introduction

There is an increasing acceptation that food can contribute to the prevention and development of some human disease conditions. Grassland management could offer means to produce milk with naturally higher concentrations of unsaturated fatty acids (FA) such as conjugated linoleic acids (CLA). The concentration of FA in herbage declined with the maturity of the plant and regrowth interval (Dewhurst *et al*., 2003 Elgersma *et al*., 2003), that could be partly explained by leaf/stem ratio evolution. Moreover, N fertilization has been shown to increase FA concentrations in ryegrass (Witkowska *et al*., 2007). This experiment was set up to examine the effects of regrowth and N fertilization of stall-fed grass on milk FA concentration.

Materials and methods

The experiment was carried out in Kubaard in the North of the Netherlands. Four paddocks, predominately *Lolium perenne*, were split in two plots that received either 73 or 37 kg N ha^{-1}. Herbage was cut daily, from 25 to 43 days of regrowth. Two groups of 18 cows were stall-fed, *ad libitum*, with either high or low N fertilized grass. The experiment started on the 15th of June and continued until the 3rd of July. Cows received additional concentrate feed according to lactation stage, which was not different between the two groups.
From both plots, grass was sampled and sward surface height (SSH) was recorded. Grass samples were analyzed for bio-chemical composition, using NIRS and for FA concentration, using gas chromatography. Milk yield was recorded individually and milk samples were analyzed for protein, fat and CLA concentration using a rapid analysing technique (Elgersma and Wever, 2005).
Sward characteristics, chemical parameters were analyzed with the General Linear Model procedure (SPSS for Windows, Rel. 11.0 Chicago: SPSS Inc.), according to the following model: Yij = µ + Ni + Dj + eijk. Where µ is general mean; Ni is the N effect (i = high or low); Dj is day effect (j = 1.15); eijk is residual term. Interaction could not be measured, because of the statistical design. LSD test was used for all pair wise comparisons. Milk fat parameters were analyzed for the N effect using a one-way ANOVA on each day separately and over the whole period by averaging for each of the 36 cows the five measurement days.

Results and discussion

The high N fertilized plots had a higher (*P* < 0.05) SSH and herbage mass (difference on average 400 kg DM ha^{-1}) than the low N fertilized plots. This difference increased during the experiment.

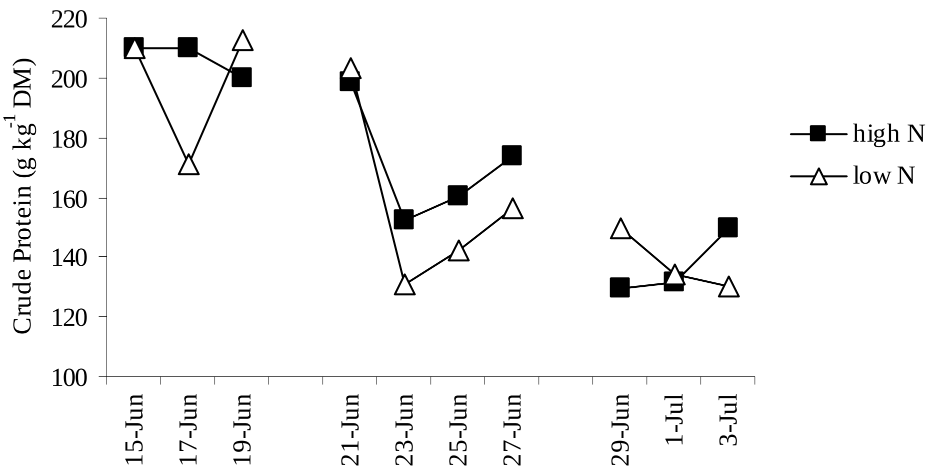

Figure 1. Crude protein concentration in grass fertilized with high or low N levels (gaps represent paddock changes)

As shown in Figure 1, there was no difference (*P* > 0.05) in herbage protein content between both N treatments, but there was a negative trend in time explained by the increasing regrowth stage of the sward. The opposite trend is visible in the NDF concentration (Figure 2), showing an increasing NDF concentration in the progress of the experiment. In the last three days of the experiment the low N treatment had a lower NDF concentration than the high N treatment.

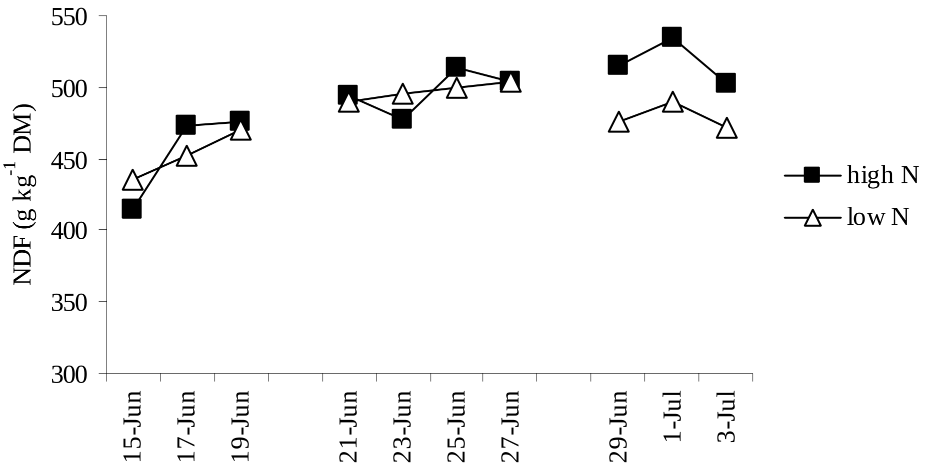

Figure 2. NDF concentration in grass fertilized with high or low N levels (gaps represent paddock changes).

The total FA concentration of the grass was not influenced ($P > 0.05$) by N fertilization. However, there was a negative effect of days of regrowth on the FA concentration in grass in the low N treatment (Figure 3).

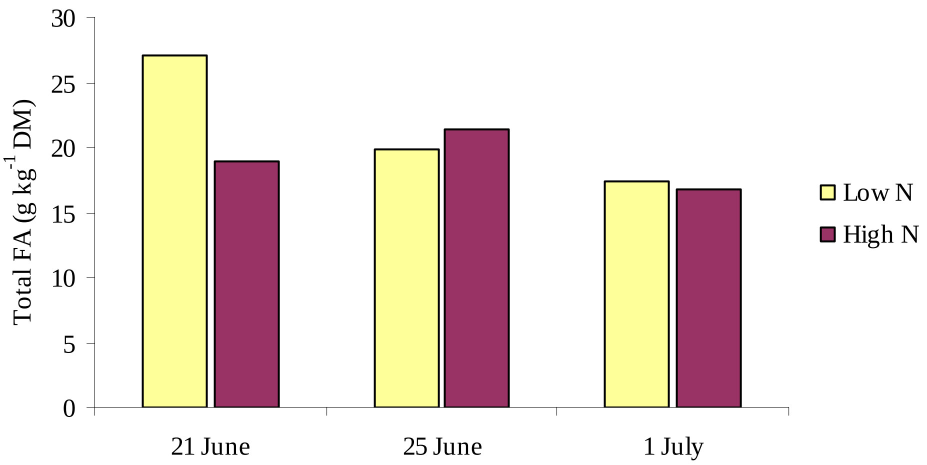

Figure 3. Total fatty acids (FA) concentration (in g kg^{-1} DM) in grass fertilized with high or low N level on three sampling dates during the experiment.

A progressing regrowth stage was associated with a lower CLA concentration in milk fat as shown in Figure 4. In general there was no effect ($P > 0.05$) of N treatment on milk fat CLA concentration. Only during the last two days of the experiment (1^{st} and 3^{rd} July), when there was a very large difference in herbage mass between the N treatments (2000 vs 4000 kg DM/ha), the CLA concentration was significantly ($P < 0.05$) higher in milk of cows fed grass from the low N treatment. This could be a result of the lower NDF concentration during these days (Figure2). The intake of low N grass might have been higher, because of a lower NDF-content (Taweel *et al.*, 2005), and therefore the intake of FA with grass might have been higher in this group. In addition, if there is more NDF in the diet, this will stimulate fibrolytic bacteria that enhance the final step of biohydrogenation in the rumen (Dewhurst *et al.*, 2003). This might explain the higher concentration of CLA in the milk.

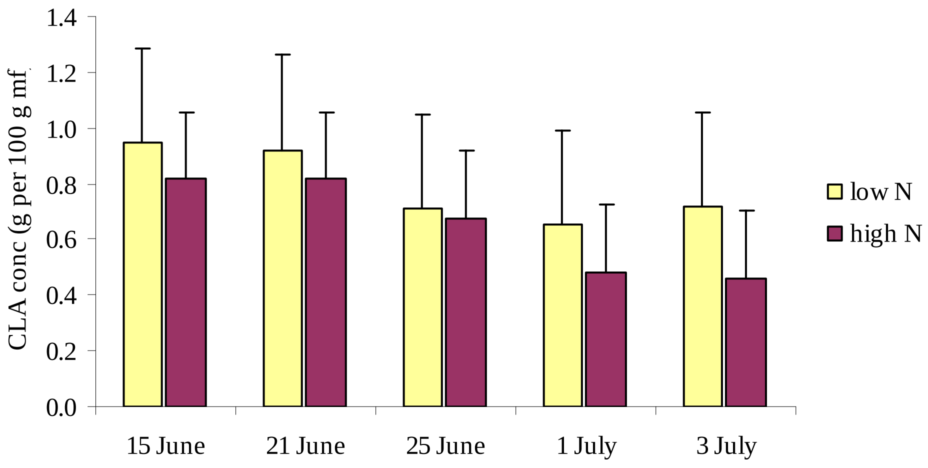

Figure 4. CLA concentration (g per 100 gram milk fat) of cows consuming a grass fertilized with high or low N, on five sampling dates during the experiment.

Conclusion

The lack of effect of N fertilizer treatment on milk FA composition may have been due to the fact that treatments unexpectedly did not differ in grass N and FA concentration, and were confounded with changes in days of regrowth. The negative effect of grass regrowth stage on herbage FA and milk CLA concentrations confirmed our hypotheses.

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