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The effect of non forage fibre on energy balance and feeding behaviour of heat stressed cows

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ABSTRACT

We examined the effect of replacing wheat hay with soya hulls on energy balance and feeding behaviour in mid-lactating dairy cows fed with concentrate diets and raised under summer condition. Cows were individually fed and faecal output was assessed by internal marker. Heat production was estimated from heart rate monitoring. Metabolizable energy intake, milk energy, heat production and energy balance, and pattern feed intake were similar in the two dietary groups. It was concluded that replacing forage NDF with NDF from non forage source, like soya hulls, is not an efficient means to reduce metabolic heat production in heat stressed cows.

KEY WORDS: dairy cows, non-forage fibre, heat increment, energy balance, heat exposure

INTRODUCTION

In dairy cows exposed to high environmental temperatures feed intake and milk yield are often reduced. Therefore, increasing the dietary nutrient concentrations may be required in order to maintain productivity at cow's potential (NRC, 1981). Additionally, formulated diets should be directed toward reduction of heat increment of feeding. Responses to diet manipulation *via* increased dietary fat, reduced protein or fibre concentration on improved milk yield in diets of heat-stressed cows have been shown (West, 1999), and explained by a reduction in metabolic heat production under high environmental temperatures. An increase in dietary concentrate/roughage ratio may lead to a reduction in heat increment and may also be caused by means of modification in rumen fermentation pattern (MacRae and Lobley, 1982). Replacement of dietary fibre from forage sources

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with non forage fibre may have similar effect, leading to a reduced ruminal acetate/propionate proportion (Mowrey et al., 1999). The main objectives of the current study were to investigate the effect replacing forage fibre with non forage fibre on diurnal pattern of feed intake, and on partition of energy budget components.

MATERIAL AND METHODS

An experiment with forty mid lactating dairy cattle, having an initial average milk yield of 40 kg/d and consuming 24 kg of dry matter (DM)/d, was performed for 80 days during the summer of 2003. Cows were divided into two equal groups based on initial performance, parity, days in lactation and body weight. Feed was supplied as a total mixed ration, containing 7.4 MJ NE_L/kg of DM, 15.5% crude protein, and 37% NDF. In the treatment group's diet 2 kg of soya hulls replaced 2 kg of wheat hay from the control diet. Hourly feed consumption was recorded by a real-time control system for individual cow (Halachmi et al., 1998).

Cows were routinely cooled by receiving three showers per day just before milking. After 8 weeks of adaptation, energy budget was studied during 1 week in 10 cows in each treatment. Nutrients digestibility was evaluated using indigestible NDF as an internal marker. Faecal grab samples were taken during a 3-day period on three representative times per day (morning, noon and evening). For the indigestible NDF assessment, dry pooled faeces and diets samples were incubated in the rumen of cannulated cows in polyester bags for 144 h. Digested energy was calculated from respective dietary and faeces ingredient composition. Metabolizable energy (ME) was calculated by the NRC (2001) equation. Heart rate was measured by a Polar monitor for a three days period. For every cow the oxygen consumption per heartbeat coefficient was calculated by simultaneous monitoring of heart rate and oxygen consumption by using the mask technique (Brosh et al., 1998). Heat production was calculated by the total number of heartbeats/d assuming 20.47 kJ/L of oxygen consumed. Milk energy was calculated from daily milk records and chemical composition of weekly milk samples.

RESULTS AND DISCUSSION

Reducing dietary fibre content can decrease the heat increment of food in heat stressed cows, and part of that alleviation might be related to the attenuation of the ratio of ruminal acetate/propionate (West, 1999). Such a change in fermentation pattern can also be achieved by replacing forage fibre with non forage fibre sources (Mowrey et al., 1999). In line with this presumption, we investigated the effect of replacing wheat hay with soya hulls, in heat stressed cows.

Average, minimal and maximal ambient temperature, relative humidity and thermal humidity index during the balance period were 27, 23, and 31^{o}C; 73, 58 and 88%; and 78, 72 and 81, respectively. These thermal indices suggest that cows in the current study were exposed to a moderate heat stress during the day, being able to dissipate some of the absorbed heat by night cooling.

The partitioning of energy into the components of heat production, milk energy and retained energy were similar between treatments, averaging 1730, 1020 and -10 kJ/kg$^{0.75}$ per day, respectively (Table 1). Soya hulls comprise more ME than wheat hay (NRC, 2001), and in non heat stressed cows replacing true forage fibre with soya hulls resulted with increased efficiency of milk production (Miron et al., 2003). However, under the conditions of the current study the overall ME intake was similar among diets. Part of the variation between these studies might be explained by the lower inclusion rate of experimental ingredient in the present study.

Table 1. Energy budget in heat stressed dairy cows

	CON[1]	SH[2]	SEM	P
Metabolizable energy intake, kJ/kg$^{0.75}$ per day	1693	1749	56	0.96
Heat production, kJ/kg$^{0.75}$ per day	995	1051	40	0.19
Milk energy, kJ/kg$^{0.75}$ per day	713	708	41	0.90
Retained energy, kJ/kg$^{0.75}$ per day	-15	-10	48	0.92

[1] control
[2] soya hulls

Increasing the number of feeds/day and offering feed during the cooler night have also been proposed as nutritional management means to combat heat stress and support dairy cattle homeostasis in warm climates (Beede and Shearer, 1992). The daily distribution of ME intake and energy expenditure, as well as time spent eating was similar in the two groups. Between 6 and 17 h, 60% of feed was consumed and 49% of heat was produced, whereas the remaining energy intake and heat were produced during the coolest part of the day. In both groups cows spent 150 min/d in eating (data not shown). The finding that feeding sessions were not shifted to the night hours may indicate that cows were adapted to their thermal environment (Morand-Fehr and Doreau, 2001). Alternatively, the heat stress was not severe enough to stimulate significant alteration in feeding pattern.

The work spent for activity during standing, feeding and ruminating, has been suggested as a potential contributor for the higher heat increment of fibrous diets (Ørskov et al., 1991). As heat production was not reduced in heat stressed cows fed with soya hulls may indicate that difference in feeding energy costs between soya hulls and the wheat hay were small. Induced alterations in heat production due to fibre intake are also related to postabsorptive increase in nutrient metabolism (Ørskov and MacLeod, 1990). Reynolds et al. (1991) reported that in cattle fed with similar amount of ME, replacing concentrates with forage increased the heat production in the whole animal by 7%. In contrast, the heat production in the current study tended rather to be 6% higher in the soya hulls group, probably due to a slight numeric increase in ME intake.

That heat production was similar in the two treatments, suggests that nutrient metabolism of the two fibre sources was similar. Dietary induced differences in rumen acetate/propionate ratio (Mowrey et al., 1999) were apparently small; due to the presence of large amount of rumen available carbohydrates in these concentrate diets.

In conclusion, under hot environmental temperatures, supplying soya hulls to heat stressed lactating dairy cows, maintained with concentrate diets do not affect energy budget components

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