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Behavioural adaptation to a short or no dry period with associated management in dairy cows

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ABSTRACT

From calving, dairy cows are typically milked for about a year, and subsequently managed to have a non-lactating or 'dry period' (DP) before next calving. However, the use of a DP may reduce cow welfare because typical DP management involves the cow changing groups and ration. Also, the DP results in a severe negative energy balance after calving. Shortening or omitting the DP may have beneficial effects on cow welfare through fewer changes in management before calving, and a lower milk yield after calving. Our objective was to assess the effects of no DP and a short DP (30 days) with associated management on feeding, lying, and number of steps of dairy cows in late gestation and early lactation. Feeding behaviour was recorded by computerized feeders for 122 periods (42 with a short DP and 80 with no DP) from week −6 to week 7 relative to calving. Steps and lying behaviour of 81 of these cows (28 with a short DP and 53 with no DP) were recorded with accelerometers in week −4 and in week 4 relative to calving only. Effects of DP treatment and parity on behaviour were analysed with mixed models. Before calving, cows with a short DP were fed a DP ration, and moved to a dry cow group. During this time, cows with a short DP spent more time lying (13.7 vs. 12.6 h per day; $P = 0.01$) and feeding (240 vs. 209 min per day; $P < 0.01$), and stepped less (663 vs. 1130 steps per day; $P < 0.01$) than cows with no DP. After calving, all cows were fed the same lactation ration and were housed in the same herd. Cows with a short DP, however, had a lower feed intake (35.7 vs 39.1 kg per day; $P < 0.01$), and spent less time lying (10.7 vs. 11.6 h per day; $P = 0.03$) after calving than cows with no DP. Milk yield was negatively correlated with daily lying time (r: −0.22; $P < 0.05$), but was not correlated with daily feeding time. Also, less time was spent on both lying and feeding after calving than before calving. These results indicate that lying time was not constrained by feeding time. Lying time was positively correlated with energy balance (r: 0.28; $P < 0.01$). Compared with a short DP with associated ration and group changes, no DP reduced lying time and increased the number of steps in late gestation, and resulted in a higher feed intake and longer lying time in early lactation.

1. Introduction

The lactation cycle of dairy cows starts with calving. From calving, cows are typically milked for about a year, and subsequently managed to have a non-lactating or 'dry period' (DP) of 6 to 8 weeks before next calving. The DP allows for treatment of intramammary infections (Robert et al., 2006), facilitates the renewal of udder cells (Capuco et al., 1997), and maximises milk yield in the next lactation (Kuhn et al., 2005; van Knegsel et al., 2013). The DP is generally considered a rest period for the cow that allows for reduced metabolic and physical activity in the last two months of pregnancy.

Whether a DP is beneficial for dairy cow welfare has been questioned (Zobel et al., 2015). Good welfare has been defined as feeling well, functioning well, and living a natural life (Fraser et al., 1997). Planned cessation of lactation, as well as being unnatural, was shown to increase udder pressure and stress (as measured by faecal glucocorticoid metabolites) at the start of the DP (Tucker et al., 2009; Bertulat et al., 2013). In addition, cows need to adapt to a new social environment and to dietary changes at the start and end of the DP, because they are typically moved to a non-lactating group

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and fed a dry cow ration (von Keyserlingk et al., 2008; Martens et al., 2012; Santschi and Lefebvre, 2014). After the DP, a higher milk yield is associated with a more severe negative energy balance (Rastani et al., 2005; van Knegsel et al., 2014). Such a negative energy balance is associated with impaired fertility and reduced metabolic health (Butler, 2003; Chen et al., 2015a,b), and may last until 3 months into lactation after a conventional DP (Rastani et al., 2005; van Knegsel et al., 2014). The prolonged lipolysis to meet energy needs may also result in exhaustion, and may have consequences for a cow's affective state (Webster, 2000; Roche et al., 2009).

Behavioural adaptation may not interfere with welfare as long as it is within the limits of the adaptive capacity of the animal (Korte et al., 2007). Behaviour of cows is affected by external factors (such as housing) and internal factors (such as behavioural needs). The behaviour patterns that are expressed are the result of these internal and external factors. Behaviour patterns can be assessed by examining the time budget and the temporal distribution of behaviours (Winter and Hillerton, 1995). Much of the time budget of dairy cattle is made up of lying, feeding, ruminating, and – in lactating cows – being milked (Gomez and Cook, 2010; Norring et al., 2012). The daily duration of these activities depends on factors such as housing, access to pasture, milking facilities, lameness, and stage of lactation (Krohn et al., 1992; Huzzey et al., 2006; Fregonesi et al., 2007; Gomez and Cook, 2010). In addition to changes in feeding time, cows were found to increase feeding rate when given limited access to resources (Munksgaard et al., 2005) and when lame (González et al., 2008). Feeding behaviour is often recorded as visits to the feeder or feed bunk. Multiple visits that occur shortly after one another can be clustered into distinct feeding bouts or meals (Yeates et al., 2001; Tolkamp et al., 2002). Meals are biologically more relevant than visits to understand short-term feeding behaviour (Tolkamp et al., 2002). Cow welfare may be compromised when cows cannot adapt their behaviour to the circumstances, or if short-term behaviour patterns result in a long-term reduction of welfare. Increased standing time, for example, is observed in early lactation (Fregonesi and Leaver, 2001; Munksgaard et al., 2005), but (on hard surfaces) is a risk factor for lameness (Cook and Nordlund, 2009).

Shortening or omitting the DP may have beneficial effects on cow welfare (Zobel et al., 2015). Both strategies improve the energy balance after calving, through a reduced milk yield and equal or better feed intake after calving (Rastani et al., 2005; van Knegsel et al., 2014). Moreover, milk yield before dry-off is lower for a short DP than for a standard DP (Pezeshki et al., 2007), because milk yield decreases towards the end of lactation. A lower milk yield before dry-off reduces udder pressure and stress in the DP (Bertulat et al., 2013), and reduces the risk of intramammary infections after calving (Rajala-Schultz et al., 2005). Cows with no DP can be kept in the herd, without regrouping and dietary changes.

It is unclear how dairy cows adapt behaviourally to a DP, and how the absence of a DP affects their time budget. Our objective, therefore, was to assess the effects of a short and no DP with associated management on feeding, lying, and number of steps of dairy cows in late gestation and early lactation. To assess possible reasons for changes in behaviour, we also studied associations between behaviour, milk yield, and energy balance in early lactation.

2. Material and methods

2.1. Experimental design, animals, and housing

The Institutional Animal Care and Use Committee of Wageningen University approved the experimental protocol in compliance with Dutch law on Animal Experimentation (protocol number 2014125). The experiment was conducted at the Dairy Campus research farm (Lelystad, the Netherlands) using 125 Holstein-Friesian cows between January 2014 and July 2015. The study was initially designed to analyse the effect of DP length and dietary energy source on energy balance and metabolic health; sample size was based on a power analysis for these variables. Cows were included in the experiment at an average rate of 3 cows per week, based on the availability of cows in late gestation. Inclusion criteria were an expected calving interval shorter than 490 days, a milk yield of >16 kg and no clinical or subclinical mastitis (a cell count > 250.000 cells/ml) at 90 days before expected calving. For practical reasons, six cows were used twice in the experiment, resulting in data for 131 periods around calving (60 periods of cows in parity 1 before calving and 71 periods of cows in parity >1 before calving).

Treatment groups were balanced for parity (1 or >1 before calving), expected calving date, and milk production in the previous lactation. This was done by grouping cows that were most similar in these aspects together in groups of 6, and randomly assigning the cows of each group to no DP (n = 87), or a short DP of 30 days (n = 44). Twice as many cows were assigned to the no DP treatment because of an additional contrast in concentrate allowance (further details will be given below).

Cows entered the experiment on Mondays, 44 ± 3 days before the expected calving date, and were kept in the study until 305 days in milk. All cows were housed in the same freestall barn with a concrete slatted floor in all alleys, and stalls (1.25 m × 2.20 m) fitted with rubber mattresses (4 cm thick) covered with sawdust. Lactating and dry cows were kept in separate groups. The stocking density in both groups was maintained at one cow per cubicle and a maximum of two cows per feeding bin throughout the experiment, with a space allowance of 7 m^2 per cow.

The drying-off protocol for cows with a short DP consisted of an abrupt transition to the DP ration at day 7 before dry-off and an abrupt transition to milking once daily at day 4 before dry-off. Cows were dried off (i.e. milked for the last time) on Mondays, 30 ± 3 days before the expected calving date. At dry-off no antibiotics were used. Dry cows were weighed in the milking parlour on Tuesdays. Lactating cows were milked and weighed in the milking parlour twice daily at about 06.00 h and 17.00 h.

2.2. Feed composition and provision

During the DP, cows received a DP ration (estimated net energy (NE): 5.4 MJ per kg DM) that consisted of grass silage, maize silage, wheat straw, and rapeseed meal in a ratio of 48:19:25:8 (DM basis), and vitamins and minerals. Cows with no DP received a lactation ration (estimated NE: 6.4 MJ per kg DM) that consisted of grass silage, maize silage, wheat straw, soybean meal, and sugar beet pulp in a ratio of 45:35:2:8:10 (DM basis), and vitamins and minerals. After calving, all cows received this lactation ration up to 49 days in milk (DIM).

Basal rations were provided in roughage intake control (RIC) feeders (Insentec, Marknesse, the Netherlands). One RIC feeder was available per two cows. Rations were mixed once daily before 10.00 h and fed twice daily around 10.00 h and 17.00 h. The RIC feeders could not be accessed by the cows when feeders were filled and from 23.45 h to 0.00 h when data records were saved. Cows had free access to water, that was provided in valve trough drinkers placed in between feeding bins and quick drainage troughs of 150L at opposite sides of the barn. Because cow density was kept constant, lactating cows had access to 3 or 4 troughs and dry cows had access to 1 or 2 troughs depending on group size.

Concentrate was provided separately from the basal ration, and the concentrate allowance differed between treatment groups. Cows with a short DP were fed a standard amount of concentrate for their expected milk yield (Short DP STD), which was based on previous data in this herd with this specific DP management (van