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Characterizing changes in activity and feeding behaviour of lactating dairy cows during behavioural and silent oestrus

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ABSTRACT

The normal time budgets of dairy cows are influenced by oestrus, with cows spending less time resting and eating but more time walking. Previous studies have shown that cows spend approximately 21% less time feeding where the day of oestrus is assumed to be the day of successful artificial insemination. The objective of the present study was to determine whether the number of steps, lying time, lying bouts, dry matter intake (**DMI**), feeding duration and the number of visits to feed were affected by behavioural and silent oestrus in lactating dairy cows. Thirty Holstein Friesian cows were housed in a free-stall barn with 34 cubicles and were continuously monitored by four video cameras. Milk samples were collected on Monday, Wednesday and Friday afternoon and analysed for progesterone concentration by enzyme immunoassay. Steps, lying time and lying bouts were measured using IceQubes (IceRobotics Ltd., Edinburgh, UK). Daily feed intakes and feeding duration were recorded by a Roughage Intake Control (**RIC**) system (Insentec B. V., Marknesse, Netherlands).

Of the 40 *behavioural* oestrus events, standing behaviour was observed in 50% of events. On the day of *behavioural* oestrus the number of steps were increased significantly ($P < 0.001$) compared to three days before (**3DB**) and three days after (**3DA**) oestrus, whilst the percentage of lying time, lying bouts, DMI, feeding duration and the number of visits to feed were reduced ($P < 0.001$) compared to 3DB and 3DA oestrus. On the predicted day of *silent* oestrus, only duration of feeding was reduced ($P < 0.03$) compared to one day before and one day after oestrus.

In conclusion, although the number of steps were increased, lying time, lying bouts, DM intake and feeding duration were reduced by *behavioural* oestrus, and only feeding duration was significantly lower during *silent* oestrus.

1. Introduction

The behavioural response of a cow to her environment is represented by the 24 h time budget (Grant, 2011). The normal time budget of a Holstein dairy cow fed a total mixed ration (**TMR**) and in free-stall housing is 3–5 h/d eating, with an average 14 feeding bouts per day, 12–14 h/d lying time, 2–3 h/d social interaction, 7–10 h/d rumination during both standing and lying time, 0.5 h/d drinking and 2.3–3.5 h/d spent outside of the yard for milking and other management practices (Grant and Albright, 2000).

In mammals, oestrus is a behavioural sign that ensures that the female is ready to be mated close to the time of ovulation. Mounting behaviour with standing to be mounted is the definitive sign of oestrus (Roelofs et al., 2010). However, over the past 30 to 50 years, the incidence of mounting behaviour has decreased from 80% to 50% in dairy cows (Dobson et al., 2008) and over the last 50 years the duration of oestrus in dairy cattle has also declined from 18 to 8 h (Dolecheck et al., 2015). Oestrus is the period of maximum sexual activity, it has been shown to range from 2 to 30 h (Hanzen et al., 2000). Standing oestrus is often defined as true oestrus, when the cow makes no effort to escape when mounted by other cows and is defined as “the interval between the first and last standing events” (Hurnik et al., 1975). Other signs of oestrus include mounting of other cows, increased activity and mucus discharge from the vulva (Sveberg et al., 2011). While standing to be mounted is considered as the primary behavioural sign of oestrus, other behaviours such as ano-genital sniffing, restlessness, bellowing, chin resting, head mounting, and an attempt to mount are considered secondary signs (Gordon, 2011).

The cows’ normal time budget can be influenced by oestrus (Yániz et al., 2006). During oestrus, the activity of dairy cows increases about 2 to 4 times compared to non-oestrus cows (Kiddy, 1977). In addition, during the period from 72 to 16 h before standing oestrus, dairy cow

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activity increases linearly with further increases during the 16 h before standing oestrus (Arney et al., 1994). In dairy cows ovulation occurs from 8 to 30 h after the onset of increased activity (Hockey et al., 2010). With the availability of activity monitoring on commercial dairy farms, restlessness has become an important indicator of oestrus (Diskin and Sreenan, 2000).

During oestrus, the time spent lying by dairy cows decreased as a result of increased activity and restlessness (Jónsson et al., 2011) driven by increased secretion of oestradiol (Sumiyoshi et al., 2014) from the developing ovulatory follicle (Allrich, 1994). According to Dolecheck et al. (2015) oestrus-synchronised cows spent less time lying than non-oestrus cows (10.19 vs 24.82 min. h, respectively) when IceQubes were used to monitor activity and Reith et al. (2014) found that dairy cows drank 15.3% less water during oestrus. In a study where the day of AI was assumed to be the day of oestrus (rather than observing for oestrus behaviour), Halli et al. (2015) found that cows spent approximately 21% less time feeding on the day of oestrus in comparison to other days of the oestrous cycle (2.82 vs. 3.54 h/d, respectively). In addition, Reith and Hoy (2012) showed that rumination was reduced on the day of oestrus from 7.2 to 5.9 h/d.

However, 35% of cows show no obvious behavioural signs of oestrus and are defined as showing silent oestrus (Palmer et al., 2010). This means that despite the use of oestrus detection aids such as activity monitors, judging the correct time for AI is difficult. The present study was designed to investigate whether the activity and feeding behaviour of lactating Holstein Friesian cows undergoing spontaneous oestrus cycle is affected by behavioural and silent oestrus.

2. Materials and methods

The experiment was undertaken between June and August 2016 at the dairy unit of Harper Adams University, Newport, Shropshire, TF10 8NB, UK.

2.1. Experimental animal, housing and management

Thirty Holstein-Friesian cows (parity 2.5 ± 1.1) with initial body weight of 637.0 ± 60.0 kg and daily milk yield of 35.8 ± 1.8 kg/d, were used at Harper Adams University dairy unit. At the start of the study the cows were 29 ± 6.3 days in milk and 2.9 ± 0.28 body condition score (Scale 1–5; AHDB Dairy, 2014). The average locomotion score (Scale 1–5; as described by Chapinal et al., 2009) of the selected cows was 2.0 ± 0.58. Cows were housed in a covered yard with 34 cubicles (2.7 × 1.2 m, with 3 cm thick rubber mattresses) and two grooved concrete passageways (6 × 50 m) giving approximately 10.8 m^2 area per cow. The cubicles were bedded with sawdust three times per week. The passageways were scrapped by an automatic scraper 4–5 times per day. Study cows were milked twice a day from approximately 05:00 and 16:30 through a 40-point internal rotary milking parlour (Wesfalia, GEA Milking System, Germany). Milking took approximately 30–40 minutes for the group.

Cows were fed through automated feed recording system from 30 bins (1.0 × 0.9 x 0.8 m; RIC, Insentec B. V. Marknesse, the Netherlands). They were moved into the study area on 6th June 2016 and data were collected until 19th August 2016. All the cows used in the study were trained to feed through RIC bins over a one week period in order to ensure that each cow could access feed without assistance. Approximately 65 kg (fresh weight) of a total mixed ration (TMR) (see Table 1) was provided daily at approximately 08:30 sufficient for ad libitum availability. Refused feed was removed three times per week on Monday, Wednesday and Friday morning at 08:00 and the RIC bins were cleaned before fresh feed was allocated. Water was provided ad libitum from three water troughs.

Feed samples were collected directly from the RIC bins daily at feeding time and immediately oven dried overnight at 105 °C to constant weight (AOAC, 2012; 934.01) for determination of dry matter (**DM**). Crude protein was determined using LECO FP 528N analyser (Leco Corporation, St Joseph, MI, USA) by combustion (AOAC, 2012; 990.03). The concentration of NDF was measured in accordance with the methods described by AOAC (2012; 2002.04). The fat content of the TMR was determined using a Soxtec system (Foss UK Ltd, Warrington, UK) using petroleum ether as described by AOAC (2012; 920.39). For ash determination, milled feed samples were ashed in a muffle furnace at 550 °C for 4 h (AOAC 2012; 942.05). Samples of TMR were sent to Sciantec Analytical Services (Stockbridge Technology Centre, Cawood, North Yorkshire YO8 3SD) for metabolisable energy (**ME**; MJ/kg DM) determination (see Table 2).

Table 1
Dietary composition of the trial ration.

Ingredient	g/kg DM	kg DM/hd
Maize silage	342.2	7.2
Lucerne	161.60	3.4
Blend	200.57	4.22
Soda wheat	113.12	2.38
Sweet starch	73.19	1.54
Soya hulls	53.23	1.12
Spey syrup	26.62	0.56
Megalac	7.13	0.15
Butterfat extra	7.13	0.15
Dairy minerals	7.13	0.15
Salt	3.33	0.07
Acid buff	3.80	0.08
Saccharomyces cerevisiae	0.95	0.02
Total	1000	21.04

(Profeed Nutrition Consultancy, UK, 2016).

2.2. Data collection

2.2.1. Video recording of oestrus behaviours

The cows were monitored to detect spontaneous behavioural oestrus using four video cameras (Voltek, KT&C Co Ltd, Seoul, South Korea) for approximately 19.46 ± 1.7 h/d. The four cameras were placed at about 5.25 m above the trial cubicles and passageways to give a clear view of the area in which cows were housed. The cameras were connected to an external hard drive video recorder (Sentient 960H, England, UK). Cows were clearly identified by numbers from 1 to 30 on both sides of the cow and individual combination of coloured tape on each cow (Kerbrat and Disenhaus, 2004). Video recordings were retrospectively reviewed to determine the time and intensity of oestrus. The scores of Van Eerdenburg et al. (2002) (Table 3) were allocated and recorded each time a sign of oestrus was observed on the video recording. The total number of points scored in a day indicated oestrus intensity.

2.2.2. Cow's activity and feed intake

To monitor cow activity, IceQubes (IceRobotics Ltd., Edinburgh, UK) were attached to the back left leg of each cow using a Velcro hook and loop strap (Dolecheck et al., 2015). The IceQube is a 3-axis

Table 2
Nutrient supplied of the ration. DM = dry matter, ME = metabolisable energy, CP = crude protein, NDF = neutral detergent fibre, OM = organic matter.

Nutrient Supplied	g/kg DM
DM (g/kg fresh)	395.3
ME (MJ/kgDM)	11.8
CP	176.0
NDF	363.5
Fat	35.6
Ash	76.7
OM	923.3