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Validation of accelerometer use to measure suckling behaviour in Northern Australian beef calves

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ABSTRACT

Knowledge of suckling behaviour in beef calves is important for understanding the health and wellbeing of both cows and calves. The present study was conducted to explore the use of tri-axial accelerometers to identify suckling bouts and suckling duration per bout in beef calves under free-range conditions. Three experiments were conducted: Experiment 1 was conducted to develop a model to characterise suckling in calves; Experiments 2 and 3 were conducted to apply the model when cattle were managed in pastoral paddock conditions. One Holstein Friesian and one Droughtmaster cow-calf pair were used in Experiment 1 for 2 days. The tri-axial accelerometer was fitted to a neck collar of the Droughtmaster calf and at the bottom and the right side of a halter on a Holstein Friesian calf on consecutive days. The initial model was developed using data collected from one calf for one day only to classify accelerometer data into suckling and non-suckling periods. In Experiment 2, 24 Belmont Red calves with accelerometers attached on the right side of the halters were visually observed for 10 days. The model was applied to raw data obtained through use of the accelerometers and the model could be used to successfully identify 98.8% of suckling bouts when compared with visually recorded behavioural data. The average suckling duration per bout recorded by accelerometers was 9.72 ± 0.20 min, whereas visually it was 9.32 ± 0.19 min. In Experiment 3, 20 Brahman calves fitted with accelerometers were visually observed for 6 h for 3 consecutive days. The model could be used to identify 95% of suckling bouts from the accelerometer data, corresponding to total number of suckling bouts observed visually. The average suckling duration per bout recorded by accelerometers was 13.69 ± 1.82 min, while with visual observations was 12.23 ± 1.77 min. The results indicate that accelerometers are a very effective tool to record suckling behaviour in beef calves in pastoral paddock conditions.

1. Introduction

Beef cows develop strong relationships with their calves before they are weaned and this bond is primarily enhanced by suckling behaviour (Lidfors and Jensen, 1988). The long-term maternal investment can be observed during this time and has important implications on calf survival and growth. Suckling behaviour, for example, leads to the development of healthy and rapidly growing calves (Von Keyserlingk and Weary, 2007) and during suckling when calves remain in close proximity to their mother also provides protection from predators. The growth of the beef calf mainly depends on the amount of milk received from its dam, especially during the early phase of their life when milk is the only source of nutrients. The average daily weight gain in calves is directly influenced by their suckling behaviour, especially suckling frequency (Valros et al., 2002) and milk quantity produced by their mother (Gleddie and Berg, 1968). Suckling is also considered to be one of the major regulators of reproductive performance as it affects the duration of postpartum anoestrus (Williams et al., 1996; Ciccioli et al., 2003) and pregnancy rate of cows (Bastidas et al., 1984).

On-farm behavioural assessment of livestock is difficult, time consuming and requires manual input of labour, especially on properties with large herds and large pastures for the cows (Martiskainen et al., 2009). The presence of humans and exposure to processing procedures, such as mustering and restraint in a squeeze chute, can alter the natural behaviour of an animal (Ishiwata et al., 2007). The majority of studies recording suckling behaviour in cattle have used direct observation methods like visual observations and video recording (Day et al., 1987; Paranhos da Costa et al., 2006) which restricted the study to a small number of animals and for short durations of time due to the physical capabilities of a human observer. All these factors can influence the validity of the results. Improved methods of data collection with less disruption to the animal are desirable for obtaining more complete datasets under pastoral settings.

Recent developments in sensor technology have resulted in new

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opportunities to study cattle behaviour in a more automated way. Technologies such as Global Positioning Systems (Handcock et al., 2009), proximity loggers (Swain et al., 2015), Taggle ear tags (Menzies et al., 2016) and accelerometers (De Passille et al., 2010) have enabled automatic monitoring of various animal activities in pastoral settings without disturbing the animal's natural behaviour. Accelerometers are a very sensitive device as compared to other precision livestock technologies and are thus well suited to study specific behaviours such as suckling. Uni-, bi- and tri-axial accelerometers have been placed at various positions on an animals body to record different behaviours. Tri-axial accelerometers have been fitted to halters on cattle to develop an automatic classification system for eating, ruminating and resting (Watanabe et al., 2008). These devices have also been mounted on neck collars fitted to cows to differentiate among feeding, standing and lying behaviour of cows (Diosdado et al., 2015), as well as, attached to the limbs of cattle to count steps and distinguish among various gait types (De Passille et al., 2010) and to assess lameness (Pastell et al., 2009). To the author's knowledge, accelerometers have not previously been used to study suckling behaviour of calves. The aim of this present study was to validate the use tri-axial accelerometers to record suckling events and suckling duration per bout in calves under pastoral conditions of northern Australia. Increasing knowledge of suckling behaviour and its physiological effect on the dam has practical significance for beef producers to adopt management strategies that can identify cows that produce healthy calves without effecting her reproductive recyclicity.

2. Materials and methods

There were two components of the study; the first determined the most effective placement of an accelerometer on a calf to record suckling behaviour using visual observations to correlate suckling behaviour with patterns in the accelerometer data. The accelerometer data from Experiment 1 was used to develop an algorithm to autonomously detect suckling behaviour in accelerometer data from calves. The second component of the study applied the model in pastoral conditions to two different cow-calf groups in Experiments 2 and 3.

2.1. Animals and sites

2.1.1. Experiment 1 – model development

Experiment 1 was conducted at the Central Queensland Innovation and Research Precinct (CQIRP) (150°51′E, 23°3′S) animal house in July 2015 for 2 days. The animal house area was comprised of a large animal shed with a small adjoining pen and five paddocks (grazed rotationally). The water trough was located in the small pen. One Holstein Friesian cross cow-calf pair and one Droughtmaster cow-calf pair (both calves approximately 2 months old) were purchased from a local breeder for this study.

2.1.2. Experiment 2 – model application on Belmont Red cattle

Experiment 2 was conducted for 18 days from 13 to 30 November 2015 in a 7 ha paddock of Belmont Research Station (150°13′E, 23°8′S), which is a 3650 ha property located 26 km north of Rockhampton in Central Queensland, Australia. The cattle used for the study were selected from a large beef herd at the Belmont Research Station. Belmont Red cow-calf pairs (n = 23) were used in the Experiment. The cow and calf mean weights (± standard error) were 434.50 ± 10.46 and 52.00 ± 2.20 kg, respectively. The age of cows ranged from 2 to 13 years and the age of calves at the start of Experiment 2 ranged from 3 to 53 days. There were 15 male and eight female calves in the group.

2.1.3. Experiment 3 – model application on Brahman cattle

Experiment 3 was conducted to further apply the technology and model developed in Experiment 1. Accelerometer data were collected from calves for 15 days, between 25 January and 8 February 2016. A group of 21, 2–9 year old Brahman (*Bos indicus*) cows with their respective 17–135 day old calves were used for the study, which was also conducted at Belmont Research Station. There were 13 male and eight female calves. The mean weights (± standard error) of cows and calves were 482.60 ± 10.07 and 125.30 ± 5.50 kg, respectively.

There was a water trough in each study site and all cattle had *ad libitum* access to water. Additional hay was provided for cattle at CQIRP as per their body weight, while cattle at Belmont Research Station had *ad libitum* access to forage for grazing. The Belmont Red cattle had a single tree for shade and the forage was improved pasture, predominantly *Panicum maximum* and *Chloris gayana,* whereas, the Brahman cattle grazed open woodland vegetation. The procedures used for the study were approved by the CQUniversity Animal Ethics Committee (approval numbers A15/03-327 and A15/07-331).

2.2. Devices fitted to cow-calf pairs

Triaxial accelerometers (USB AccelerometerX16-4, weighing 48 g, Gulf Coast Data Concepts, LLC, Waveland, USA; http://www.gcdataconcepts.com) were used to collect acceleration values on x, y and z axes. A sample rate of 12 Hz (12 readings/sec) was selected. The devices could only be used for short periods (up to 20 days) due to limits of data storage capacity and battery. Given this was the first time using an accelerometer on a calf to measure suckling behaviour, various positions were initially trialled to determine the most appropriate location for precise data collection.

2.3. Experimental procedure

2.3.1. Experiment 1 – model development

A halter with an accelerometer attached was fitted to the Holstein Friesian calf. On day one, the accelerometer was located on the bottom of the halter. On day two the accelerometer was moved to the right side of the halter. The Droughtmaster calf had an accelerometer attached to the bottom of a neck collar. The calves were previously familiarised with wearing the halter and collar prior to the Experiment 1 to avoid any behavioural changes during data recording.

On the first day of the experiment (Day 1: 08:00 h), the cows and calves were brought from the paddock area into a small pen adjoining main animal shed. The calves were separated from the cows and brought into the animal shed. Devices were fitted and the calves were re-joined with their mother in the adjoining pen. Visual observations recorded the start and end time of all behaviours of the calves such as walking, sitting, drinking, grazing and suckling. Observations were made 1 h after placing the devices on the calves until the devices were removed from the calves at 16:00 h. The same procedure was repeated on day 2, with the position of the accelerometer on the halter moved from under the chin to the right side of the jaw of the Holstein Friesian calf, while the position of the accelerometer remained unchanged on the Droughtmaster calf. At the end of day 2, the cows and calves were moved back to the paddock where they had been before the observational period was initiated.

2.3.2. Experiment 2 – model application on Belmont Red cattle

On day 1, 23 cow-calf pairs were brought into the yards, calves were separated from their dams and randomly allocated an accelerometer. Accelerometers were fitted to the right side of a halter (Fig. 1), which was determined to be the most effective placement to measure suckling behaviour from Experiment 1. The calves were re-joined with their dams and observed for 2 h to ensure the collars were not causing any adverse behaviours. Once all of the animals were settled, the group was moved to their assigned paddock.

Visual observations commenced 1 day after fitting devices. Behavioural sampling with continuous observation was used to record all occurrences of suckling events (including calf identification, start and end time of suckling). Observations were conducted between 6:00 and 18:00 h on weekdays until the day prior to removing the devices.