Applied Animal Behaviour Science 175 (2016) 2–7

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Associations between milk intake and activity in the first days of a calf's life and later growth and health

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ARTICLE INFO

Article history:
Accepted 3 October 2014
Available online 23 October 2014

Keywords:
Dairy calf
Milk intake
Calf vigour
Weight gain
Health
Activity

ABSTRACT

We examined whether calves' milk intake and activity in the days after birth predict later growth and the risk of illness. Female Holstein calves ($n = 130$) were housed in individual pens where they were allowed *ad libitum* milk from birth to 5 days of age. Daily milk intakes were recorded and accelerometers attached to the calves measured time spent standing and lying down. After 5 days, calves were housed in group pens with four to nine calves per group and allowed 12 L/day of milk and *ad libitum* hay and starter from automated feeders. Calves were weighed at birth (birth weight = BW) and at 28 days of age and health status was determined daily. Digestible energy (DE) intakes were calculated from feed intakes. During days 2–4, there were large differences among calves in the amount of milk consumed, which ranged from 7.3% BW/day (2.4 L/day) to 30.5% BW/day (12 L/day) with a median of 16.3% BW/day (6.7 L/day). Twenty-one calves were treated for illness from days 6 to 28. These calves had lower milk intakes on days 2, 3 and 4 than calves that remained healthy ($P < 0.05$). For the calves that did not become ill, milk intake on day 4 was correlated ($r = 0.29$; $P < 0.01$) with ADG from days 0 to 28 and correlated ($r = 0.33$; $P = 0.03$) with the residual body weight on day 28 (when birth weight and digestible energy intakes from days 5 to 28 were accounted for using multiple regression). Time spent standing from days 2 to 4 varied between calves but was not correlated with BW, milk intake during days 2–4, or weight gains to day 28 ($P > 0.10$). Very young calves can drink large quantities of milk, and the calves that drink the largest amounts in the first days of life have greater long-term growth rates and are less likely to become ill. Milk intake may be a better sign of early calf vigour than activity levels.

1. Introduction

The health and growth of unweaned dairy calves are important issues for dairy producers. Poor weight gains before weaning may increase the age at first calving and reduce later milk yield (Bach, 2012; Soberon et al., 2012), while calf morbidity and mortality reduce later production and profitability (Heinrichs and Heinrichs, 2011; Mohd Nor et al., 2012; Stanton et al., 2012) and are important welfare issues for the dairy industry (Mellor and Stafford, 2004). It would be useful to detect unhealthy or slow growing calves at an early age.

Low milk intake is a good indicator of illness (Borderas et al., 2009a) and may be a sign of poor future growth. During the first few days of life, there are large differences in milk intake even between calves on the same milk

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http://dx.doi.org/10.1016/j.applanim.2014.10.002
0168-1591/

allowance (Borderas et al., 2009b) but the consequences of this for later growth and health are not known. Feeding milk at the amounts typical in the dairy industry (8–10% body weight) can lead to weight losses during the first few days of life, which are less likely to be seen when calves are fed *ad libitum* (Borderas et al., 2009b; Cole, 1937). Much is known of the consequences of low colostrum intake during the first day of life, and an increasing amount is known of the longer-term consequences of overall pre-weaning feed intake and growth rates (Bach, 2012; Soberon et al., 2012). However, little is known of the longer-term consequences of low milk intake during the first few days of life.

Calf vigour may also be a potential indicator of later calf performance (Murray and Leslie, 2013). Calves with poor vigour are more likely to die before weaning (Riley et al., 2004) and have reduced colostrum intake (Murray and Leslie, 2013; Vasseur et al., 2009). Calf vigour can be assessed by the new-born calf's ability to stand after delivery without human assistance (Godfrey et al., 1991; Vasseur et al., 2009) and Vasseur et al. (2009) noted a positive correlation between the time spent standing in the first hour after birth and colostrum intake. Research has so far focused on the calf's vigour at birth but vigour over a longer time period may be as or more important in predicting longer term performance. Recent technological developments now allow time spent standing to be measured automatically (Ledgerwood et al., 2010), which could facilitate assessment of calf vigour over a longer time period.

The objectives of the study were to describe the milk intake of calves during their first days of life and to examine the relationship between activity and milk intake during the first few days after birth and subsequent pre-weaning feed intake, growth and health.

2. Material and methods

All procedures were approved by the local Institutional Animal Care Committee following the guidelines of the Canadian Council for Animal Care.

2.1. Calves and treatments

We used 130 female Holstein calves (birth weights shown in Table 1), housed in individual pens (2.0 × 1.1 m, with sawdust bedding on concrete) within 12 h of birth, and bottle fed at least 4 L of pooled colostrum in a single meal within 6 h of birth. Blood samples were collected from the jugular vein 24 h after the first feeding of colostrum, and serum was analysed using a Reichert AR 200 digital hand-held refractometer (Reichert, Depew, NY, USA). Only calves having a serum protein level >5.5 g/dL were included in order to avoid illness due to inadequate colostrum intake.

From days 2 to 5 of age, calves were allowed to drink pasteurized waste milk from the dairy herd to *ad libitum* intake. Calves had continuous access to milk provided in plastic buckets connected by a hose to a nipple, with fresh milk served at approx. 09:00 h and 15:00 h. Milk refusals (milk left in the bucket at next milk delivery) were recorded at these times by weighing each bucket. No water or starter feed was provided from days 2 to 4 of age. At 5 days of age, the calves were disbudded using caustic paste after sedation with xylazine (Vickers et al., 2005). To measure activity, 60 of the calves were fitted with a triaxial accelerometer (Hobo Pendant G Acceleration Data Logger, Onset Computer Corporation, Pocasset, MA, USA) on day 1 attached with Vet Wrap (Co-Flex, Andover Coated Products Inc., Salisbury, MA, USA) to the lateral side of the hind leg as described in de Passillé et al. (2010). The accelerometer was set to record calf position every minute (Ledgerwood et al., 2010).

At 6 days of age, the calves were transferred to 7 m × 4.68 m group pens with a sawdust-bedded resting area (4.47 m × 4.68 m) and plastic-coated expanded metal floors (2.53 m × 4.68 m) in front of the feeders (described in Sweeney et al., 2010). They were normally kept in groups of eight individuals, but because of deaths or delays in birth there were 12 groups of eight, three groups of seven, one group of nine and one group of four calves. Calves were fed milk and starter from automated feeders, with both feeders controlled by a single computer (CF 1000 CS Combi, DeLaval Inc., Tumba, Sweden). Calves were allowed 12 L/day pasteurized milk (herd averages of 3.97% fat, 4.10% protein, 3.30% lactose from bulk tank samples) at 40 °C and had *ad libitum* access to a textured calf starter (CP = 17.9% on a DM basis, with the main ingredients being 16% wheat, 14% barley, 13% canola meal, 13% oats, 10% soya, 10% corn, and 4% molasses: Unifeed Ltd., Chilliwack, BC, Canada). Grass hay (DM = 90.8%; CP = 15.1%; NDF = 51.1%; ADF = 33.6%) and water were available *ad libitum* from automated feeders which weighed the intake of each calf at each meal (RIC, Insentec B. V. Marknesse, The Netherlands). Calves were weaned off milk in various ways but we included only calves that began weaning after 28 days of age.

Each day of treatment for illness was recorded for each calf. This was done by the normal barn staff who were blind to the experimental objectives. A rehydrating solution (Hydrafeed, EXL Laboratories, Minneapolis, MN, USA) was administrated to calves with diarrhoea. A bovine respiratory treatment (Resflor GOLD®, Intervet Inc. Roseland, NJ, USA) was provided to calves with respiratory illness. Calves with more severe illness (e.g. both respiratory infection and diarrhea) were administrated an NSAID (Metacam 20 mg/mL, Boehringer Ingelheim, Burlington, Ont., Canada) and an antibiotic (Procillin, Vétoquinol Canada, Lavaltrie, QC, Canada) following veterinary advice.

The birth weight and weight at 28 days of age were recorded using a portable scale (Western Scale Co., Vancouver, BC, Canada) accurate to 10 g.

2.2. Statistical analysis

Data collected for each calf included birth weight (kg), body weight (kg) at day 28, daily milk intakes (L) on days 2, 3 and 4, daily intakes of milk, grain starter and hay from days 6 to 28, and any treatment for illness. Day 2 began at the first midnight after the calf was born. The milk intake at day 1 of age was not included because this was not always available and the milk intake on day 5 was not used because of the possible effects of the disbudding