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Ketonemia in dairy goats: Effect of dry period length and effect on lying behavior

G. Zobel,*[1] K. Leslie,† D. M. Weary,* and M. A. G. von Keyserlingk*[2]
*Animal Welfare Program, Faculty of Land and Food Systems, University of British Columbia, 2357 Main Mall, Vancouver, British Columbia, V6T 1Z4, Canada
†Department of Population Medicine, University of Guelph 2536 Stewart Building, Guelph, ON, N1G 2W1, Canada

ABSTRACT

In dairy animals, a successful transition from one lactation to the next includes minimizing negative energy balance. Cows experiencing excessive negative energy balance typically develop metabolic complications following parturition (e.g., ketosis); does are also susceptible before kidding (e.g., pregnancy toxemia). It is not known to what extent the provision and the length of the dry period affect these conditions in does. Furthermore, whereas clinical symptoms of these conditions include lethargy, behavioral changes resulting from ketosis and pregnancy toxemia have not been quantified in small ruminants. The aims of this study were to (1) describe the relationship between the dry period and negative energy balance, and (2) determine if lying behavior changes are indicative of the metabolic status of dairy goats. A total of 420 does on 10 commercial dairy goat farms in southern Ontario, Canada, were enrolled in the study (mean ± SD: 42 ± 18 does/farm). Each doe was affixed with a data logger to measure lying behavior from 12 d before to 12 d after kidding. Blood samples were collected at least once before and at least once following kidding to determine blood β-hydroxybutyrate (BHBA) concentration as an indicator of negative energy balance. Does were categorized as healthy (HLTH; both pre- and postkidding samples BHBA <0.9 mmol/L), PREGTOX (prekidding BHBA ≥1.7 mmol/L), or KET (postkidding BHBA ≥1.7 mmol/L). Behaviors were analyzed according to 5 periods: P−2 (d −12 to d −2 relative to kidding), P−1 (d −1 relative to kidding), P0 (d 0, kidding day), P1 (d 1 relative to kidding), and P2 (d 2 to 12 relative to kidding). Dry period length and milk production after kidding were recorded when available. Farms ranged from 0 to 15% and 0 to 50% in prekidding and postkidding ketonemia, respectively. The HLTH does had shorter dry periods compared with PREGTOX and KET does (43 vs. 55 d, SE of the differences of means = 4 d). One farm kept some does milking, while drying off others; on this farm more PREGTOX and KET does (11/28) were found in the dry group versus the continuously milked group (1/16). Overall, does that had ketonemia before kidding (PREGTOX) spent more time lying down compared with healthy does (16.1 vs. 12.7 h/d, SE of the differences of means = 0.9). Both PREGTOX and HLTH does had increased lying bouts in P−2 compared with the day before (P−1) kidding [(mean (95% CI): 16.8 (15.8–17.8) vs. 20.5 (19.4–21.8) bout/d]. Compared with HLTH does, animals that were ketonemic following kidding (KET) had higher mean lying times throughout the study (14.5 vs. 13.5 h/d, SE = 0.4). Previous work has shown a relationship between shorter and skipped dry periods and improved energy balance in dairy cows; the current study is the first to indicate a similar relationship in dairy goats. Furthermore, goats that developed ketonemia, particularly before kidding, displayed decreased activity, including longer lying times and fewer lying bouts in the days around kidding.

Key words: dry off, metabolic disease, pregnancy toxemia, negative energy balance

INTRODUCTION

The transition between lactations is a challenging time for dairy animals in commercial production systems. Several management practices (e.g., feed changes, cessation of milking, and dry period length), as well as the physiological transitions between lactational and nonlactational states, and vice versa, have the potential to negatively affect welfare. A dry period is generally recognized as important for achieving optimal milk production (e.g., cows: Bachman and Schairer, 2003; ewes: Hernandez et al., 2012; does: Caja et al., 2006). The positive effects of the dry period on metabolic health are less certain.

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[1]Current address: AgResearch Limited, 10 Bisley Street, Private Bag 3123, Hamilton, New Zealand.
[2]Corresponding author: nina@mail.ubc.ca

The end of the dry period and the beginning of the next lactation are frequently associated with a period of negative energy balance. This can be a consequence of increasing energy requirements of the growing fetus before parturition, as well as from the increasing metabolic demands of milk production after parturition. Although many animals are able to cope and recover from negative energy balance by metabolizing body fat, some animals metabolize too much fat, become overwhelmed with the associated by-products (e.g., NEFA and ketone bodies), and develop pregnancy toxemia (before parturition) and ketosis (following parturition). While ketosis may persist subclinically in cows, creating milk production losses (e.g., Rajala-Schultz et al., 1999; Goldhawk et al., 2009), pregnancy toxemia is often fatal in does and ewes if not diagnosed in a timely manner (e.g., Rook, 2000; Lima et al., 2012). In cows, the link between short or no dry periods and reduced risk of ketosis is clear (Rastani et al., 2005; de Feu et al., 2009). The metabolic health effect of carrying multiple fetuses (Forbes, 1968; Navarre and Pugh, 2002), and poor quality or restricted feed during the dry period (Laporte-Broux et al., 2011), are well known in does and ewes. However, the effect of dry period length has received little attention in these species.

Lethargy is commonly cited as a symptom of ketosis in cows, but evidence of reduced activity in sick animals has only recently been described (Itle et al., 2015). No similar evidence exists for does and ewes. Identifying and quantifying reduced activity could be particularly important in small ruminants because prognosis is poor by the stage at which clinical symptoms are documented. The majority of behavioral monitoring of goats to date has used either live observation (Loretz et al., 2004; Patt et al., 2013) or video (Loretz et al., 2004; Aschwanden et al., 2009). These methodologies have limited application in large commercial settings. Accelerometer-based data loggers are efficient in monitoring activity levels in cows (e.g., Ito et al., 2009; Medrano-Galarza et al., 2012), but to date their application in goats has been minimal (e.g., Patt et al., 2012), and they have not been applied during kidding or to assess health status. Therefore, the study had 2 objectives. First, we sought to assess how does with pregnancy toxemia and ketosis vary with regard to provision of a dry period and dry period length. Second, we aimed to explore the merits of using changes in lying behavior (as assessed using data loggers) as early indicators of pregnancy toxemia and ketosis in dairy goats.

MATERIALS AND METHODS

This study was conducted in accordance to the University of British Columbia's Animal Care Certificate A12–0249 and the University of Guelph's Animal Use Protocol 1636 as well as Behavioral Research Ethics Board at the University of British Columbia (H12–02311) and the University of Guelph's Research Ethics Board (12NV014).

Farms and Animals

Ten commercial dairy goat farms in southern Ontario, Canada, participated in this trial. At the time of enrollment, farms were milking on average ± SD 326 ± 176 does (range: 100–650 milking does). From these farms, a total of 420 multiparous, late gestation does (mean ± SD: 42 ± 18 does/farm) were enrolled. Of these, 231 does were still milking and 189 does were already in the dry period. Most does were crossbred and were predominantly Saanen, Alpine, and La Mancha; one farm was composed entirely of the Saanen breed. Does were cared for according to each farm's established management protocols, and no changes to housing or general care were made by the research team. Feeding practices fell into 1 of 3 broad categories: (1) mixed forage supplemented with grain or concentrate, (2) TMR, or (3) complete pellet supplemented with straw, hay, or both. All farms dried off their does late in lactation, but one farm employed selective dry-off management, keeping high-producing does milking.

Lying Behavior

Approximately 2 wk before each doe's anticipated kidding date, a HOBO Pendant G data logger (Onset Computer Corporation, Bourne, MA) was attached vertically to a rear leg above the metatarsophalangeal joint using a self-adherent veterinary bandage (Vetrap, 3M, St. Paul, MN) and foam pieces. Loggers were set to record at 1-min intervals. Loggers were removed and replaced every 21 d until approximately 2 wk of lying behavior before and after kidding was collected for each doe. Data were summarized according to the methodology outlined in Zobel et al. (2015) to calculate daily lying time and lying bout frequency for each doe. Early kiddings, doe deaths, logger failures, and lost loggers resulted in an average of 19 ± 4 d of logger data per doe.

Ketonemia

Pregnancy toxemia and ketosis are associated with ketonemia, or elevated blood BHBA. The BHBA was measured using a Precision Xtra meter (Doré et al., 2013; Pichler et al., 2014) on blood samples collected via jugular venipuncture. Samples were collected at least once before kidding; if a doe did not kid within 14 d of