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The effect of milk-feeding method and hay provision on the development of feeding behavior and non-nutritive oral behavior of dairy calves

K. C. Horvath and E. K. Miller-Cushon¹

Department of Animal Sciences, University of Florida, PO Box 110910, Gainesville 32611

ABSTRACT

We investigated the interactive effects of common feeding management factors on the development of feeding and non-nutritive oral behaviors in preweaned calves through the weaning transition. Calves were randomly assigned to 1 of 3 treatments that differed by milk-feeding method (teat or bucket) and ad libitum access to chopped timothy hay: control, milk provided by bucket and no access to hay (CON; $n = 10$); milk provided by bucket and access to hay (H; $n = 10$); milk provided via a teat and access to hay (TH; $n = 10$). Calves had ad libitum access to concentrate and water, and were fed 6 L/d of pasteurized waste milk, divided into 2 meals. All calves were weaned by removing the second milk meal for 9 ± 2 d, beginning at 36 d of age. Daily concentrate and hay intake were recorded, and calves were weighed weekly to measure growth. We recorded the behavior of all calves using 2 s time-lapse video during time periods that encompassed milk meals, from 6000 h to 1000 h and 1600 h to 2000 h, on 2 consecutive focal days in wk 2 and 4. We continuously monitored lying time and activity using electronic data loggers. During the preweaning period, hay selection by H and TH calves was subject to a treatment \times week interaction, with TH calves increasing hay intake to a greater extent over time. Similarly, we observed a tendency for a treatment \times week interaction for hay dry matter intake. Before weaning, concentrate intake was subject to a treatment \times week interaction, increasing to a greater extent over time for H and TH calves, but was greater overall for CON calves. As predicted, milk-feeding method and hay provision influenced the proportion of time devoted to feeding and non-nutritive behaviors. The CON calves spent the greatest amount of time performing non-nutritive sucking directed at the pen, TH calves the least, and H calves intermedi-

ate amounts. Considering the time TH calves sucked on their teat when milk was not present in addition to the time they spent sucking on pen fixtures, the total amount of time spent performing sucking behavior was similar between treatments. Although intake was similar across the weaning transition, CON calves had greater average daily gain than H calves, and TH calves were intermediate. Providing access to hay and milk via a teat during the milk-feeding stage decreased non-nutritive oral behaviors and influenced feeding behavior.

Key words: dairy calf, feeding behavior, non-nutritive oral behavior

INTRODUCTION

Providing calves with alternative feeding methods may influence feeding behavior and the development of abnormal behaviors. Non-nutritive oral behaviors, including sucking pen fixtures and cross-sucking, are considered to be detrimental to calf health (Babu et al., 2004) and are more likely to develop in calves not fed by a teat (Hammell et al., 1988). Non-nutritive oral behaviors are a redirection of natural sucking behavior (Jensen and Weary, 2013) and can occur in response to limited food availability (Bokkers and Koene, 2001), among other factors. However, dairy calf management practices can influence the development of feeding behavior (Miller-Cushon and DeVries, 2015).

Calves are typically reared individually on-farm and are often fed milk by bucket, which provides little opportunity to perform the natural sucking behavior (de Passillé, 2001). Sucking behavior is highly motivated, and young ruminants raised separately from their mothers will suck each other and parts of their pen, even when given adequate nutrition (de Passillé, 2001). Additionally, bucket-fed calves have been observed licking more pen fixtures than calves fed by teat (Jensen and Budde, 2006). Understanding the calf's motivation to suck would help us devise feeding and management systems that allow calves to express their natural behaviors, reduce the development of abnormal behaviors, and improve performance (de Passillé, 2001). A rubber

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¹Corresponding author: emillerc@ufl.edu

teat can act as an outlet for sucking behavior, and the action of sucking on the teat elicits the release of hormones involved in digestion (de Passillé, 2001; Lupoli et al., 2001), reduces cross-sucking in group-housed calves (Jung and Lidfors, 2001), and may reduce non-nutritive behaviors in individually housed calves.

Access to forage may also influence the development of non-nutritive oral behavior. Providing hay reduces non-nutritive sucking (Haley et al., 1998) and influences rumen development (Khan et al., 2011b). Access to more water and roughage suppresses cross-sucking in group-housed calves (Bokkers and Koene, 2001). Calves fed only milk will nibble on parts of their stalls as a redirection of their nibbling motivation, but providing concentrate and straw has been shown to reduce non-nutritive nibbling in calves (Veissier et al., 1998). Calves have consistently been observed selecting a proportion of hay in their diet, and this suggests that they are motivated to consume it (Phillips, 2004; Miller-Cushon et al., 2013b). Providing hay can improve feed efficiency and growth (Coverdale et al., 2004; Castells et al., 2012), as well as the rumen environment (Khan et al., 2011b).

Provision of a teat and access to forage have been found to independently influence feeding behavior and the development of non-nutritive oral behaviors in dairy calves, but it is not clear how these feeding methods may interact to affect calves' behavioral development and performance. This study examined the effects of both hay provision and teat access on the development of feeding patterns, non-nutritive oral behavior, and general calf performance and activity in restriction-fed calves through the milk-feeding stage and across the weaning transition. We hypothesized that hay selection would be influenced by milk-feeding method: calves provided with a teat would direct oral behaviors toward this outlet and select less hay. We also predicted that calves provided with hay or a teat and hay would exhibit fewer non-nutritive oral behaviors than calves fed by bucket with no access to hay, and that a greater cumulative effect would occur in calves provided with both a teat and hay.

MATERIALS AND METHODS

Animals and Management

A total of 30 Holstein heifer calves were enrolled at birth at the University of Florida Dairy Unit (Hague, FL). They were fed 4 L of quality-controlled colostrum and uniquely identified with radiofrequency identification (RFID) ear tags. Calves were housed in individual wire-mesh pens (0.9 × 1.8 m, width × depth) that

permitted visual and auditory, but not tactile, contact with other calves for the duration of the experiment. Calves were managed according to the standard operating procedures for this facility. All pens were located in an open-sided barn that protected calves from downward wind and rain. Pens were bedded with sand that was replaced weekly. Calves received 6 L of pasteurized waste milk mixed with a powdered enhancer (Pasteurized Milk Balancer Protein-Blend, Purina Animal Nutrition LLC, Shoreview, MN) in 2 daily meals, delivered at 0600 h and 1800 h. Calves had ad libitum access to calf starter (Ampli-Calf STR 20P R50 DBZ9.1 medicated, Purina Animal Nutrition LLC) with supplement (SMI 3.5G AS700 CMB medicated, Purina Animal Nutrition LLC) and water. Calves were disbudded by a University of Florida veterinarian during wk 4 of life using a hot iron. A veterinarian monitored the health of the calves weekly, and calves were healthy for the duration of the experiment. All study procedures were reviewed and approved by the University of Florida Animal Care and Use Committee.

Experimental Design

At birth, calves were randomly assigned to 1 of 3 treatments that differed by milk-feeding method and access to hay: control (**CON**; n = 10), access to hay (**H**; n = 10), and access to milk through a teat and hay (**TH**; n = 10). Calves assigned to the CON treatment were housed using the conventional method for the facility and received milk via a bucket that was placed inside the pen and removed within 5 min after the milk was consumed; concentrate was provided as the sole source of solid feed. Calves assigned to the H treatment received milk via bucket, ad libitum access to concentrate by bucket, and chopped timothy hay (2 inches) in a bucket separate from the concentrate. Calves assigned to the TH treatment received milk via a rubber teat (Peach Teats; Skellerup Industries, Christchurch, New Zealand); the milk bucket was placed outside the pen and a line was fitted to a 1-way valve connecting the bucket to the teat at the front of the pen. The teat remained in place throughout the day, but the line and bucket were removed within 5 min after the milk meal had been consumed. The TH calves received ad libitum access to chopped timothy hay (2 inches) by bucket, in addition to concentrate. The assigned feeding method continued throughout the milk-feeding stage. All calves were weaned by removing the second milk meal for 9 ± 2 d (weaning was subject to staff schedule, so it varied slightly in length), beginning in wk 6. Calves were followed for an additional 10 d postweaning. Solid-feed rations were maintained throughout the experiment.

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