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Short communication: Effect of straw inclusion rate in a dry total mixed ration on the behavior of weaned dairy calves

M. J. Groen,*† M. A. Steele,‡[1] and T. J. DeVries*[2]
*Department of Animal and Poultry Science, University of Guelph, Kemptville Campus, 830 Prescott Street, Kemptville, ON, K0G 1J0 Canada
†Animal Nutrition Group, Wageningen University, PO Box 338, 6700 AH Wageningen, the Netherlands
‡Nutreco Canada, 150 Research Lane, Guelph, ON, N1G 4T2 Canada

ABSTRACT

The primary objective of this study was to determine the effect of straw inclusion levels on the feeding behavior of young, weaned calves adapted to a dry total mixed ration (TMR) composed of a multitextured concentrate and chopped straw. A secondary objective was to determine how developed feeding patterns persist after calves were switched to a conventional silage-based diet. Ten Holstein bull calves (91 ± 2.4 d of age, weighing 136 ± 12.3 kg) were assigned to 1 of 2 treatments: a TMR containing [dry matter (DM) basis] either (1) 85% concentrate and 15% chopped straw for 10 wk (wk 1 to 10) or (2) 85% concentrate and 15% chopped straw for 5 wk (wk 1 to 5), then 70% concentrate and 30% chopped straw for 5 wk (wk 6 to 10). After 10 wk, all animals were transitioned to a TMR containing (DM basis) 42.3% corn silage and 57.7% haylage for 2 wk (wk 11 to 12). During wk 1 to 5, all calves had similar DMI (5.5 kg/d), average daily gain (1.7 kg/d), feed efficiency (3.5 kg of DM/kg of gain), and eating time (151.9 min/d). During wk 6 to 10, calves transitioned to the 70% diet ate less DM (5.5 vs. 7.4 kg/d), grew more slowly (1.3 vs. 1.6 kg/d), sorted more against long forage particles (62.8 vs. 103.8%), and had greater feeding times (194.9 vs. 102.6 min/d). The difference in feeding time occurred only during the first 8 h after feed delivery. Despite similar DMI (5.2 kg/d) and average daily gain (1.1 kg/d) in wk 11 to 12, differences in behavior were observed resulting from previous diets. In wk 11 to 12, calves previously fed the 70% diet continued to have a longer meal immediately after feed delivery. Overall, the results indicate that diluting a dry TMR containing a multitextured concentrate and chopped straw with more straw resulted in calves spending more time feeding and having longer meals immediately after feed delivery; this feeding pattern carried over after calves were transitioned to a silage-based ration.

Key words: feeding behavior, straw, dairy calf, total mixed ration

Short Communication

Total mixed rations are designed as a homogeneous mixture with the goal to minimize the selective consumption of individual feed components by dairy cattle (Coppock et al., 1981). It is for this reason that providing feed as a TMR, rather than separately feeding the grain concentrate and forage components, is the most common method of feed delivery used on commercial dairy farms for nearly all classes of animals over 6 mo of age. Recent data suggests that providing TMR to young, weaned heifers results in heifers consuming their ration more consistently and reduces the amount of sorting against forage and for concentrate (DeVries and von Keyserlingk, 2009; Greter et al., 2010a). Feeding a TMR to heifers from a young age not only has immediate behavioral effects, but may also have longer-term benefits to these animals. Greter et al. (2010b) found that heifers previously fed a top-dressed ration, maintained similar feeding patterns (whereby they were slug feeding their concentrate) after they were switched to a silage-based TMR (for a period of 7 wk).

Currently little is known about the effects of feeding a dry TMR to young, weaned dairy calves. The primary objective of our study was to determine the effect of straw inclusion level on the feeding behavior of weaned calves adapted to a dry TMR composed of a multitextured concentrate and chopped straw. A secondary objective was to determine how feeding patterns developed during this period persist after calves are switched to conventional silage-based diet.

Ten male Holstein calves were used in our study. The calves were purchased at birth from commercial dairy farms in eastern Ontario and were housed at the University of Guelph, Kemptville Campus Dairy Education and Research Centre (Kemptville, ON, Canada). The calves were managed according to standard operating

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[1]Current address: Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, T6G 2P5 Canada.
[2]Corresponding author: tdevries@uoguelph.ca

procedures of this facility, in accordance with policies and guidelines of the Canadian Council on Animal Care (CCAC, 2009).

Prior to the present study, calves were pen-housed either in pairs or individually during the milk feeding period (d 1 to 49 of life) and offered milk replacer [Shur-Gain Optivia (26:16) Advantage Milk Replacer; Nutreco Canada Inc., Guelph, ON, Canada] ad libitum via a teat, a texturized concentrate, and water. Throughout the postweaning period (d 50 to 91), calves were provided a complete high-fiber pelleted diet (Shur-Gain High Fiber Dairy Heifer Ration; Nutreco Canada Inc.; 91% DM, 21% CP, 18% ADF, 36% NDF).

For our study, at 91 ± 2.4 d of age (mean ± SD), calves (136.0 ± 12.3 kg) were individually housed in pens (2.44 × 1.83 m; width × depth). The front of each pen had 2 gates. The left gate had 2 openings for access to water pails (diameter = 33.7 cm, height = 31.1 cm, capacity = 19 L) mounted on the outside. The right gate had 2 openings for access to a feed bucket (width = 81.3 cm, height = 42.2 cm, capacity = 106 L) mounted on the outside. Pens were located under a 3-sided, roofed barn and were bedded with wood shavings, with bedding replaced 3× a week and fresh bedding added as needed. The study was conducted between August and November 2013.

To ensure that the number of animals per treatment was adequate to detect statistical differences in treatment response, a power analysis (Morris, 1999; Hintze, 2008) was performed before the study for the primary response variables, including feed sorting and feeding behavior. Estimates of variation for these variables (mean CV = 12%) were based on previously reported values (DeVries and von Keyserlingk, 2009; Greter et al., 2010a; Miller-Cushon and DeVries, 2011a; Miller-Cushon et al., 2013b). From the power analysis, it was determined that at 80% power, treatment differences of ~15% could be detected at this sample size.

Calves were randomly assigned to 1 of 2 treatments: a TMR containing (on a DM basis) either (1) 85% concentrate (Shur-Gain Optivia 22% Rumimax Transition Calf Ration; Nutreco Canada Inc.) and 15% chopped wheat straw for 10 wk (wk 1 to 10) or (2) 85% concentrate and 15% chopped wheat straw for 5 wk (wk 1 to 5), then 70% concentrate and 30% chopped wheat straw for 5 wk (wk 6 to 10). All animals were on the same diet (85% concentrate) for the first 5 wk to allow calves to adapt to the diet, in particular to the forage component for which they previously had no experience. During those first 10 wk, TMR was manually weighed and mixed for each animal daily. Wheat straw was chopped with a New Holland 355 Grinder Mixer (New Holland Inc., New Holland, PA) to pass through a 1.9-cm mesh screen. At 23 wk of age, all animals were transitioned to a silage-based TMR, containing 42.3% corn silage and 57.7% haylage, on a DM basis, for a period of 2 wk (wk 11 to 12). The TMR was prepared daily in a TMR mixer wagon (Jaylor 4425, Jaylor Fabricating, Orton, ON, Canada) and manually weighed for each animal. The ingredient and chemical composition of the diets are listed in Table 1. Feed was provided once daily at 1000 h in amounts to ensure 10% orts; this level of orts was chosen to ensure sufficient feed was leftover to sample for feed sorting. Water and trace mineral salt blocks (Windsor TM Stock Salt, The Canadian Salt Company Limited, Pointe-Claire, QC, Canada) were provided ad libitum.

Intake of feed was recorded daily based on offered and refused quantities of feed. The calves were weighed at the same time each day on 2 consecutive days each week. Weekly ADG was calculated as the difference between average weights taken 1 wk apart divided by 7. Feed-to-gain ratio was calculated by dividing DMI by ADG for each calf.

The behavior of calves was recorded throughout the study using 6 color video cameras (Day/Night Camera, model no. WV-CP504; Panasonic, Osaka, Japan) fitted with an F0.95, 2.8- to 8-mm lens (Fujinon CCTV lens, Fuji, Tokyo, Japan). Cameras were connected to a digital video recorder (Digital Disk Recorder, model no. WJ-HD616K, Panasonic) set to record at 7.5 images/s. Cameras were positioned above the pens such that each individual pen was fully visible from 1 of the cameras (~2 m in front of the pens and 4 m from the pen floor). Four red lights (100 W) were spaced evenly between cameras and placed on a timer to provide enough light to record during nighttime hours. Characterization of feeding behavior, using digital video recordings, occurred on 3 d (d 1 to 3) in wk 1, 3, 5, 6, 8, 10, 11, and 12. Video was reviewed using 1-min instantaneous scans (as validated by Miller-Cushon and DeVries, 2011b) for 24 h/d. At each scanning interval, whether the calf was consuming feed (defined as taking place when a calf's head was lowered in the feed bucket) was recorded.

Lying behavior was recorded on the same weeks that feeding behavior was recorded, using electronic data loggers (Hobo Pendant G Data Logger, Onset, Pocasset, MA). These devices measured leg orientation at 1-min intervals and allowed all lying behavior data to be collected electronically (as validated by Bonk et al., 2013). The loggers were placed on the calves' rear leg with bandaging tape (Vetrap Bandaging Tape, 3M, London, ON, Canada), before 1000 h on d 1 of each recording week and removed after 7 d of complete recordings.

Fresh samples of the TMR and orts from all animals were taken for DM and nutrient composition analysis (Table 1) on d 1, 3, and 5 of each week. Duplicate