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Interaction between the physical form of the starter feed and straw provision on growth performance of Holstein calves

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ABSTRACT

Two experiments were conducted to assess the effect of physical form of a starter feed with or without straw supplementation on growth performance of Holstein calves. In experiment 1, a total of 32 calves were randomly assigned at 7 d of age to texturized starter feed (containing rolled barley, corn, and oats) without straw, texturized starter feed with chopped straw, and pelleted starter feed with chopped straw. All calves were offered 4 L of pasteurized whole milk twice daily from 7 to 35 d of age, 2 L of milk twice daily from 36 to 42 d of age, and 2 L of milk from 43 to 49 d of age. Animals were weaned at 50 d of age, and the study finished when calves were 63 d old. In experiment 2, a total of 60 calves (8 d of age) were randomly assigned to texturized starter feed (containing whole corn) without straw, pelleted starter feed without straw, and pelleted starter feed with chopped straw. All calves were offered the same milk replacer (MR; 23% crude protein and 19.5 fat) at 11% dry matter concentration, 4 L/d of MR until 14 d of age, 6 L/d of MR from 14 to 37 d, 3 L/d of MR from 38 to 44 d, and 1.5 L/d of MR from 45 to 52 d of age. The experiment finished when calves were 58 d old (1 wk after weaning). Rumen liquid pH was measured after weaning. In both studies, calves were individually housed in pens on sawdust bedding and starter feed and chopped straw were offered free choice in separate buckets. In experiment 1, starter feed and straw intake and growth did not differ among treatments. However, calves receiving straw showed a greater rumen pH compared with those not receiving straw. In experiment 2, pelleted started feed supplemented with straw fostered an increase in solid feed intake (as percentage of body weight) compared with a pelleted or texturized starter feed without straw supplementation. However, calves that received the texturized starter feed containing whole corn had rumen pH similar to those fed a pelleted starter feed with straw. Feeding a texturized starter feed containing rolled barley, corn, and oats (with or without straw provision) was not able to maintain rumen pH or promote growth and intake compared with offering a pelleted starter feed with chopped straw. However, when whole corn was used in the texturized starter feed, rumen pH was equivalent to that obtained with a pelleted starter feed and straw supplementation.

Key words: calf, forage, texturized starter feed, straw

INTRODUCTION

Early weaning and restricted-milk feeding programs have been widely used as strategies to reduce feeding cost of rearing young calves and encourage starter feed consumption in dairy calves. However, research during the last decade has shown advantages of providing more milk or milk replacer on improving calf growth, welfare, and future productivity, which requires reevaluation of the effects of solid feeds (starter feed and forage) on the performance of developing calves (Khan et al., 2011a). Feeding forage to calves fed restricted amounts of milk has traditionally been discouraged because it could decrease voluntary intake of starter feed because of a potential accumulation of undigested fiber in the rumen (Drackley, 2008). However, some dietary fiber may be necessary for young calves to maintain abrasion in their rumen and avoid abnormal development of the rumen (Greenwood et al., 1997), especially if the starter feed does not have adequate particle size. For example, feeding diets containing fine particles and a high proportion of processed grains has triggered rapid production of acids in the rumen (Laarman et al., 2012), decreased rumen pH (Laarman and Oba, 2011), and impaired development of rumen epithelium (Greenwood et al., 1997). Drackley (2008) pointed out that if concentrate feeds contain some long particles, such as whole oats, corn, beet pulp, or cottonseed hulls, forage supplementation is not needed, especially if calves are bedded on straw. These starter feeds, typically referred to as texturized, have been reported to increase starter feed intake compared with pelleted starter feeds (Bach

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et al., 2007; Porter et al., 2007) accompanied either with (Porter et al., 2007) or without improvements in growth performance (Bach et al., 2007).

An alternative to avoid abnormal development of the rumen epithelium without using a texturized starter feed could be to offer a pelleted starter feed along with provision of chopped forage. Several authors (Thomas and Hinks, 1982; Khan et al., 2011b; Castells et al., 2012) reported that offering forage in the diet of young calves improved performance and concentrate intake, although in one study (Khan et al., 2011b), growth was mostly due to a confounding effect of gut fill because forage intake was well above 5% of solid feed intake (it was close to 25%). However, to our knowledge no previous study has evaluated the interaction between the physical form of a starter feed and the provision of roughage to young calves. Thus, the current experiments were designed to evaluate growth performance of calves fed starter feeds differing in physical form (texturized or pelleted) with or without chopped straw.

MATERIALS AND METHODS

Experiment 1

This study was conducted at the Dairy Education and Research Center of the University of British Columbia in Agassiz (BC). Animals were managed according to the guidelines of the Canadian Council on Animal Care. Thirty-two Holstein calves (23 heifers and 9 bulls) born during summer and fall were separated from their dams and moved to individual pens (1.7 × 1.2 m) located in a well-ventilated barn and bedded with sawdust. Calves were fed 4 L of colostrum within 4 h of birth and then received 4 L of pasteurized whole milk twice daily (at 0800 and 1800 h) until reaching 7 d of age. At 7 d of age (initial BW = 46.4 ± 4.91 kg), calves were randomly assigned to 1 of 3 dietary treatments: pelleted starter feed and chopped straw (**PS**), texturized starter feed and chopped straw (**TS**), and texturized starter feed without straw (**TX**).

All ingredients in the pelleted starter feed were ground to 3 mm and then pelleted, whereas in the texturized starter feed corn, barley, and oats were rolled and the rest of the ingredients were also ground to 3 mm and then pelleted. Pelleted and texturized starter feeds had the same ingredient and nutrient composition (Table 1) and differed only in their physical form. The pelleted starter feed was pelleted at 4 mm of diameter and 18 mm in length. The texturized starter feed contained 46.2% of pellets (4 mm of diameter and 18 mm long), and the rest was rolled grains (18% corn, 23% barley, and 12.8% oats; Table 1). Chopped rye-grass straw was used in the study. The straw was chopped using a TMR mixer (Loewen Horizontal Mixer, Loewen Welding & Manufacturing Ltd., Matsqui, BC, Canada) at 19,000 rpm for 60 min. The particle-size distribution of straw was determined using the 3-screen Penn State Particle Separator (Kononoff et al., 2003). Chopped straw contained 50 ± 6.0% long (>19 mm) particles, 29.5 ± 5.2% medium (8–19 mm) particles, 17 ± 1.3% short (1.18–8 mm) particles, and 3.5 ± 0.5% fine (<1.18 mm) particles. Chopped rye-grass straw contained 92% DM, 8.2% CP, 72.2% NDF, and 53% TDN.

Calves were bottle fed and received 4 L of pasteurized whole milk twice daily (at 0800 and 1800 h) from 7 to 35 d of age, 2 L of pasteurized whole milk twice daily from 36 to 42 d of age, and 2 L of pasteurized whole milk daily from 43 to 49 d of age. Calves were weaned at 50 d of age. Calves had free access to water from a bucket. Starter feed and chopped straw were offered ad libitum in separate buckets until the end of the study when calves reached 63 d of age.

Starter feed, straw, and milk intakes were recorded daily on an individual basis. Calves were weighed twice weekly about 2 h from the morning feeding. Heart girth, body barrel, and hip height were measured at the beginning and at the end of the study (7 and 63 d of age). Blood samples (10 mL) were collected at 21, 35, 49, and 63 d of age from the jugular vein to evaluate the evolution of BHBA with age. Rumen liquid was collected 3 to 4 h after the morning feeding using an oral tube at 35 (preweaning), 49 (weaning), and 63 (postweaning) d of age to measure rumen pH using a digital pH meter (pH Testr 30, Eutech Instruments Pte. Ltd., Singapore). Samples of starter feeds, straw, and milk were taken weekly to analyze their nutrient composition.

Samples of whole milk were analyzed for DM (24 h at 103°C), ash (4 h at 550°C), N content using the AOAC (1990) method (988.05) adapted for an automatic distiller Kjeldhal (Kjeltec Auto 1030 Analyzer, Tecator, Sweden) with $CuSO_4$/Se as a catalyst instead of $CuSO_4$/TiO_2, and ether extract using the AOAC method (920.39) with petroleum ether for distillation instead of diethyl ether (AOAC, 1990). Samples of starter feed and straw were analyzed for DM, ash, and CP following the same methods described above, plus NDF with sodium sulfite and heat-stable α-amylase (Van Soest et al., 1991).

Blood samples were analyzed for BHBA (Precision Xtra blood ketone kit, Abbott Diabetes Care, Madrid, Spain) using the procedures described by Iwersen et al. (2009).

Experiment 2

This study was conducted at a commercial contract heifer operation (Recria Segle XXI) in Vilanant (Giro-