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Supplemental fat for dairy calves during mild cold stress

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ABSTRACT

Eighty-one Holstein and Holstein-cross dairy calves fed calf milk replacer (CMR) were used to determine response to increasing amounts of supplemental fat during mild cold stress. Calves (n = 27) were randomly assigned to 1 of 3 treatments: (1) low fat [LF; 28% crude protein:15% fat milk replacer (28:15 MR)]; (2) medium fat [MF; 28:15 MR + 113 g/d of commercial fat supplement (FS)]; (3) high fat (HF; 28:15 MR + 227 g/d of FS). The MF and HF calves received FS from d 2 to 21, and all calves were fed LF from d 22 to 49. The CMR was fed at 1.4% of birth body weight (BBW) from d 1 to 10, at 1.8% of BBW from d 11 to 42, and at 0.9% of BBW from d 43 to 49. Calves were weaned on d 49 and remained in hutches until d 56. The CMR was reconstituted to 13% solids. Calves were fed a commercial starter grain (19.2% crude protein on a dry matter basis) ad libitum and offered warm water after CMR feeding. Calves were fed CMR twice daily at 0630 and 1730 h in hutches bedded with straw. Starter intake, CMR intake, and ambient temperature were measured daily, and body weight (BW), hip height, and body length were measured weekly. Data were analyzed using PROC MIXED in SAS (SAS Institute Inc., Cary, NC) as a randomized design with linear and quadratic contrasts. Calf BBW averaged 42.0 ± 1.0 kg, total serum protein averaged 5.8 ± 0.1 mg/dL, and birth ambient temperature averaged 5.0 ± 1.1°C. Feeding FS increased metabolizable energy intake (ME_I) over maintenance but decreased efficiency of conversion of BW gain:ME_I. Starter intake by LF calves was greatest until the beginning of weaning, after which starter intake was similar among treatments. Because of higher starter intake, total ME_I was similar among treatments. Feed efficiency through d 49 was greater for calves fed MF and HF. Average daily gain during fat supplementation was greater for MF and HF than for LF. Lack of increase in BW gain and feed efficiency between MF and HF treatments indicated that HF did not result in advantages over MF. Supplementing fat to preweaned calves fed CMR increased BW gain and decreased starter intake through d 21 which had carryover effects on starter intake on d 49 and reduced hip height and tended to reduced withers height and body length by d 56. The addition of supplemental fat to LF, during mild cold stress, may result in a suboptimal ratio of crude protein to metabolizable energy in the CMR.
Key words: preweaned dairy calf, milk replacer, supplemental fat, cold stress

INTRODUCTION

One of the most commonly experienced stressors in livestock is caused by fluctuations in environmental temperature that extend beyond the thermoneutral zone. The reported lower critical temperature (**LCT**) for a newborn dairy calf ranges from 13°C (Curtis, 1974) to 8°C (Young, 1981). As the temperature falls below the calf's LCT, a calf needs more dietary energy to maintain body temperature (Curtis, 1974; Young, 1981; NRC, 2001). If calves are fed the same amount of milk as under moderate environmental conditions, less energy will be available to support growth (Khan et al., 2011). Limited data are available to evaluate the effect of supplemental fat for preweaned calves during cold stress. Supplementing whole milk or milk replacer with 113 g/d of supplemental fat increased BW gain during the first month of life (Jaster et al., 1990); however, those authors did not collect subsequent measurements after the first month of age. Additionally, research has demonstrated that additional fat added to milk replacer boosts daily gains during cold weather (Jaster et al., 1992). During the last 2 wk of their 6-wk trial, however, Jaster et al. (1992) observed no response or a negative carryover response after fat was discontinued, indicating that the abrupt change in milk replacer fat supplement or the shift in CP:ME had a negative effect on calf growth. Numerous studies have investigated effects of varying the FA profile of calf milk replacer (Jenkins et al., 1985; Piot et al., 1999; Hill et al., 2007; Mills

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et al., 2010); however, few studies have been designed to specifically target the amount of supplemental fat fed during the early preweaned phase. Increasing rates of milk replacer feeding have been shown to increase growth rates, reduce starter intake, and delay rumen development (Bar-Peled et al., 1997; Jasper and Weary, 2002; Terré and Bach, 2007). Increasing the amount of dietary fat has previously been reported to increase body fat gain and reduce protein deposition (Tikofsky et al., 2001; Bascom et al., 2007; van den Borne et al., 2007). Cold-stressed calves, however, might benefit from supplemental fat by sparing glucose and AA, which are used for thermoregulation when calves are managed in conditions below the thermal neutral zone. Milk fat concentration of maternal transition milk, as well as whole milk, indicates that calves are naturally programmed to consume high-fat milk during the early days of life (Bernal-Santos et al., 2003). Supplemental fat might reduce amount of AA catabolized for energy, resulting in a greater proportion of dietary AA available for lean tissue growth. To test this hypothesis, milk replacer must be fed that provides sufficient amounts of protein to meet the AA requirements of preweaned calves for growth and maintenance (Donnelly and Hutton, 1976; Bartlett et al., 2006). Enhanced early nutrition capitalizes on growth efficiency early in life being driven more by increasing protein and lactose intake than by increasing fat intake (Tikofsky et al., 2001; Hill et al., 2008). Supplemental fat might also spare energy that can be used for functions beyond growth, including immune function (Nonnecke et al., 2003). Khan et al. (2007) found that providing calves a large amount of milk early in life and then reducing milk intake before weaning (step-down method) caused a surge in solid feed intake. Removing supplemental fat from milk replacer could be considered an alternative approach to inducing a similar step-down effect on starter intake without altering the amount of milk replacer fed. Supplemental fat might be optimally positioned early in the first 3 wk when nutrient intake from starter is expected to be low. Questions remain regarding the amount of supplemental fat to optimize calf nutrient intake for calf growth and health during cold stress. The objectives of this experiment were (1) to determine if increasing fat intake during the first 21 d of the preweaned phase alters energy intake over maintenance, efficiency of growth, and voluntary starter intake, and (2) to determine if response in calf performance is altered by supplemental fat amount. We hypothesized that supplemental fat would decrease starter intake during the first month of the preweaned phase but energy available for growth would be greater, resulting in increased calf growth.

MATERIALS AND METHODS

Animals

The experimental protocol was reviewed and approved by the University of Minnesota Institutional Animal Care and Use Committee. Eighty-one (n = 27 per treatment) Holstein and Holstein-cross calves born at the University of Minnesota Dairy Teaching and Research Center (St. Paul, MN) were enrolled in the study. At birth, calves were removed from their dams and identified with a unique ear tag. Then, birth body weight (**BBW**) was recorded, navels were dipped, and each calf remained in a heated indoor pen for the first 48 h after birth. Calves received approximately 1.9 L of colostrum at each of the first 3 feedings (within 2 h after birth and again approximately 12 and 24 h after the first feeding) and were trained to drink calf milk replacer (**CMR**) from buckets during the first 4 d of life. A blood sample was collected via jugular venipuncture into evacuated serum collection tubes (SST Vacutainer, Becton Dickinson, Franklin Lakes, NJ) 24 h after birth and centrifuged at 2,000 × *g* for 20 min. Serum was separated and analyzed for total serum protein concentration using a refractometer (Rhino VET360, Reichert, Depew, NY); serum total protein averaged 5.8 ± 0.1 mg/dL. Serum hematocrit was not measured. Each calf was placed in a calf hutch (PolyDome, Litchfield, MN) bedded with wheat straw.

Assignments to Treatments and Feeding

Experimental design was a randomized design with 3 treatments. Calves were assigned to 1 of 3 treatments: (1) low fat [**LF**; 28% CP, 15% fat milk replacer (**28:15 MR**)]; (2) medium fat [**MF**; 28:15 MR + 113 g/d of commercial fat supplement (**FS**)]; (3) high fat (**HF**; 28:15 MR + 227 g/d of FS). The MF and HF calves received FS from d 2 to 21, and all calves were fed LF from d 22 to 49. Calf milk replacer was reconstituted to 13% solids and fed at 1.4% of BBW from d 1 to 10, at 1.8% of BBW from d 11 to 42, and at 0.9% of BBW from d 43 to 49. Calves were fed CMR twice daily at 0630 and 1730 h in hutches. Calves were weaned on d 49 and remained in hutches until d 56. Calves were fed a commercial texturized starter grain ad libitum (Table 1). Starter refusals were recorded daily and refusals of CMR were recorded at each feeding. To provide ad libitum drinking water, approximately 4 to 10 L of drinking water was provided daily depending on calf age. Calves were bedded with straw on Tuesday and Saturday of every week. Quality of calf bedding was evaluated 3 times weekly (Monday, Wednesday, and Friday) using nesting scores when calves were lying down in hutches