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Effect of different fat supplements on performance of dairy calves during cold season

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ABSTRACT

The objective of this experiment was to evaluate the effects of starter supplementation with fat sources differing in their fatty acid (FA) profile on performance of dairy calves during cold season. Sixty Holstein calves (3 d of age; 39.7 ± 3.8 kg of body weight) were randomly assigned to 1 of 5 starter diets supplemented with (1) no fat or oil source (control), (2) 3% palm fat (PLF), (3) 3% soybean oil (SBO), (4) 3% tallow (TAL), and (5) a 3.2% mixture (MIX) of PLF, SBO, and fish oil. The fat supplements were substituted for corn in the basal starter diet. Both the control and fat-supplemented diets contained similar amounts of dietary crude protein (19.4%), but the latter had a slightly higher quantity of calculated metabolizable energy (3.17 vs. 3.07 Mcal/kg) than did the former. Calves were reared outdoor in individual pens during the cold of winter with a mean ambient temperature of 5.0°C during the study period. Whole milk was offered twice daily from d 3 to 45 and once from d 46 to 49. The animals were weaned on d 50 and monitored in their individual pens until d 70. Supplementation with SBO and MIX increased both the dietary concentration and ratio of essential FA (n-6 and n-3), whereas supplementation with TAL and PLF made no change in the essential FA profile. Starter intake and average daily gain were not affected by PLF and TAL supplements, but were reduced as a result of feeding MIX. Feeding supplemental SBO did not affect starter intake, but tended to improve average daily gain and final body weight. Fat sources had no effects on body skeletal measurements, fecal score, digestibility, ruminal pH, ammonia, and total volatile FA concentrations; however, feeding MIX increased rumen molar proportion of propionate. No differences were observed in blood metabolites across the treatments during the preweaning period. Plasma concentrations of triacylglycerol and cholesterol increased when fat sources were supplemented and glucose concentration increased when SBO was supplemented during the postweaning period. Overall, addition of 3% PLF or TAL to the diet of young calves failed to improve growth performance. Although addition of SBO and MIX increased the dietary essential FA concentration, calf performance was only improved when SBO was supplemented.
Key words: young calf, fatty acids, feed efficiency, cold season

INTRODUCTION

Recent studies have shown that intensified feeding of heifer calves during the preweaning period has a range of long-term positive effects including reduced age at conception and calving, increased BW at calving, and improved milk production (Gelsinger et al., 2016). The dairy industry has now progressively changed from a restricted allowance of about 4 L/d of milk to more generous allowances (6 L/d or more), partly because of long-term performance (Bach, 2012). However, greater allowances might result in lower rates of rumen development and postweaning ADG by depressing starter intake (Davis and Drackley, 1998). Feeding extra energy as fat is another way to increase BW gain, as is feeding a high amount of liquid feed, especially during periods of subthermoneutral temperatures (Jaster et al., 1992). On the other hand, rearing young calves in outdoor facilities during the winter months increases the energy requirement due to cold stress. If calves are fed the same amounts of nutrients as under moderate environmental conditions, less energy will be available to support growth. Holt (2014) reported that calves raised in winter months consumed more calf starter than those born in other months, but had the same weight gains as other seasons. Limited data are available to evaluate the effect of supplemental fat in starter diets for young calves during cold stress. The addition of 5, 10, and 20% fat from Ca-soaps in starter diets linearly reduced both intake and ADG (Fallon et al., 1986). Hill et al. (2015) found that, compared with starters containing tallow or no fat, those including 2% soybean oil reduced calf starter intake and ADG. On the other hand, Araujo et

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al. (2014) reported that feeding a high-fat starter diet containing 11.2% fat accompanied by offering 6 L/d of milk replacer resulted in increased overall BW and growth.

Various types of supplemental fat with different mixes of individual fatty acids (**FA**) have been fed to dairy cattle (NRC, 2001). However, NRC (2001) recommends a low fat level in calf starters (~3%), as feeding high-fat diets (>6%) or fat feeding under normal weather conditions have been reported to cause negative effects on calf feed intake and growth (Fallon et al., 1986; Hill et al., 2015; Kazemi-Bonchenari et al., 2016). In addition to the utilization of FA as an energy source, certain FA (PUFA) are biologically active molecules. Linoleic (C18:2) and α-linolenic (C18:3) acids, as well as the very long chain PUFA (i.e., C20:4n-6, C20:5n-3, and C22:6n-3), are essential for membrane fluidity and neural development and for the production of eicosanoids, which have numerous physiological and metabolic properties (Berg et al., 2002). However, no defined essential FA requirement exists for ruminants (Palmquist, 2010). Partially replacing coconut oil with porcine lard in milk replacer increased intake of linoleic and α-linolenic acids and improved calf performance and some aspects of immunity (Garcia et al., 2014). Typical starter diets based on corn and soybean meal contain relatively low concentrations of C18:2 and C18:3, and are almost devoid of C20:4, C20:5, and C22:6 (Hill et al., 2009). Hill et al. (2011, 2015) observed that different FA supplementation in calf starter had different effects on calf intake, performance, and health status.

In the current study, we hypothesized that supplementation of starter diets with fat at the typical inclusion rate (~3%) during cold weather (which increases energy requirement) would not adversely affect feed intake, thereby improving energy intake and growth performance of young calves. Moreover, it is less clear whether different types of FA have differential effects on these responses. The objective of our study was to determine whether the intake of energy or FA with differences in their chain lengths, saturation, or chemical form (SFA, MUFA, PUFA, rumen inert, and unprotected FA) would have different effects on the performance of calves raised in winter.

MATERIALS AND METHODS

Calves, Diets, and Management

The experiment was conducted at the facilities of the dairy farm of FKA Animal Husbandry and Agriculture Co. (Isfahan, Iran), during the period from November 2014 to February 2015, the typical cold season in the region (Table 1). A total of 60 Holstein calves (35 females; 25 males) were separated from their dams (second parity or more) shortly after birth and fed 6 L of colostrum within the first 12 h of life (3 L of colostrum within 2 h of life and 3 L in a second feeding). Calves were housed outdoors in 1 × 2 m individual pens at ambient temperature. The interior of each pen was bedded with wood shavings, and replenished every 24 or 48 h. At d 3 of age, the calves (39.7 ± 3.8 kg of BW) were fed 1 of the following 5 diets: (1) a basal starter with no fat supplement (**CON**), (2) 3% of dietary DM as palm fat (**PLF**; Energizer RP-10, IFFCO, Johor, Malaysia), (3) 3% of dietary DM as soybean oil (**SBO**; Naz Industrial Vegetable Oil Co, Isfahan, Iran), (4) 3% of dietary DM as tallow (**TAL**; Lador Fat, Ala Roghan Sepahan Co. Isfahan, Iran), or (5) 3.2% of dietary DM as a mixture (**MIX**; 1:1:1.2, wt/wt) of PLF, SBO, and Ca salt of fish oil (StrataG, Virtus Nutrition, LLC, Corcoran, CA). Assuming that typical starter diets (based on corn grain and soybean meal) contain about 50% of their FA as linoleic acid and 3% as α-linolenic acid (n-6:n-3 ratio >15; Hill et al., 2009), the MIX treatment was formulated with soybean and fish oils to provide an approximate n-6–to–n-3 ratio of 6:1, which is the optimum recommended level for human infants (Klein, 2002). The FA profiles of the supplemental fat sources were provided by the manufacturer (Table 2). The basal diet contained alfalfa hay, corn, barley, and soybean meal. Fat supplements partially replaced corn grain (Table 3). Calves were offered concentrate and chopped alfalfa hay ad libitum as mixture. Metabolizable energy of starter feeds was calculated according to NRC (2001). Calcium concentration was increased from 0.72% in the CON diet to 0.90% in the fat-supplemented diets on the grounds that fat supplementation has been shown to reduce the digestibility of dietary Ca (NRC, 2001). The calves received 4 L of whole milk/d from d 3 to 20, 5 L/d from d 21 to 25, 6 L/d from d 26 to 45 (twice daily), and 3 L/d milk during morning feeding from d 46 to 49 of age. Water was also provided through the nipples. Finally, animals were weaned at 50 d of age and maintained on the study until 70 d of age.

Measurements, Sample Collection, and Chemical and Biochemical Analysis

Daily fecal scoring was performed in the morning (0800 h) as follows: 1 = normal, 2 = soft to loose, 3 = loose to watery, 4 = watery, mucous, slightly bloody, and 5 = watery, mucous, and bloody. The amounts of starter diets offered and refused were recorded daily throughout the experiment. To determine apparent digestibility, fecal samples were obtained twice a day (in