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Soymilk as a Novel Milk Replacer to Stimulate Early Calf Starter Intake and Reduce Weaning Age and Costs

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ABSTRACT

The primary objective was to determine the effects of partial replacement of whole milk with soymilk on preweaning calf performance and weaning costs. Following 3 d of colostrum and transition milk feeding, 18 male and 9 female neonatal Holstein calves (41.6 ± 1.6 kg of body weight; mean ± SE) were assigned in a completely randomized design to 3 treatments offered at 10% of body weight (wet basis) including 1) whole milk (control), 2) 75% whole milk + 25% soymilk (S25), or 3) 50% whole milk + 50% soymilk (S50). The weaning criterion was defined as the calf age at a daily intake of ≥900 g of starter concentrate. During the first 2 wk of the experiment, treatments did not differ in starter intake and fecal score. Calves fed S25 gained similar amount of body weight as calves fed whole milk diet. By 49 d of age, also, calves on S25 gained similar body weight as did calves on whole milk diet. Calves on S25 and S50 achieved the weaning criterion, respectively, about 10 and 12 d earlier than did peers on whole milk. The soymilk-fed calves consumed less milk than control calves to meet the weaning criterion owing to promoted starter intake. Feed-related weaning costs dropped by about 35% when soymilk was fed because whole milk was about 50% more expensive than both soymilk and starter concentrate. Feeding soymilk at up to 50% of the milk diet maintained health during the first 2 to 4 wk of age when the neonate calf is highly sensitive to nonmilk proteins and plant antinutrients. Results introduce soymilk as an economic partial substitute for whole milk in calf-raising facilities.

Key words: calf, soymilk, starter, weaning

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INTRODUCTION

Any strategy that can stimulate early starter intake in dairy facilities without compromising calf health will reduce weaning age and costs (NRC, 2001). Neonate calves possess little activity of starch and nonstarch carbohydrases and proteinases (Van Soest, 1994). An adequate and early supply of moderately fermentable dry feed is necessary for the timely establishment of amylolytic, fibrolytic, and proteolytic capacities in the reticulorumen (Sander et al., 1959; Maiga et al., 1994; Van Soest, 1994). Early reticulorumen development will subsequently lower weaning age, save milk, and reduce feed and labor costs (Anderson et al., 1987; NRC, 2001). Soy protein sources such as soy protein concentrate and soy protein isolate have partly been used in milk replacers (Silva et al., 1986; Drackley et al., 2006). Soy protein preparations, however, contain antigenic and phenolic compounds which adversely affect intestinal integrity and calf growth during the first 2 to 4 wk of life (Gardner et al., 1990; Lallès et al., 1995a,b; Drackley et al., 2006).

The dairy industry, particularly in regions where weaning occurs late, is in much need of economical milk replacers that can maintain normal calf health during the first 2 to 4 wk of age and make calf-raising more profitable. Soymilk is cheaper and contains less protein and fat compared with milk (NutritionData, 2007). We propose that due to the lower nutrient content of soymilk than whole milk, its partial substitution for whole milk will drive calf appetite toward dry starter, will stimulate butyrate and propionate production, and will thereby hasten reticulorumen development (Sander et al., 1959; Baldwin et al., 2004). The faster reticulorumen development will enable early weaning and reduce calf-raising costs (Davis and Drackley, 1998). In addition, timely weaning will improve calf health (NRC, 2001). Our principal objective was to determine the effects of partial replacement of whole milk with soymilk on preweaning calf performance and feed-related weaning costs.

MATERIALS AND METHODS

Experimental Design, Calves, and Treatments

Eighteen male and nine female neonate Holstein calves with BW of 41.6 ± 1.6 kg (mean ± SE) were used

Table 1. Feed ingredients and chemical composition of the calf starter concentrate (DM basis)

Ingredient	%
Ground barley grain	18.0
Ground corn grain	36.5
Solvent soybean meal	34.0
Wheat bran	6.0
Alfalfa meal	2.0
Anzymite[1]	1.5
Mineral and vitamin supplement[2]	0.5
Dicalcium phosphate	1.5
Chemical composition	
Dry matter	88.2
NE_M,[3] Mcal/kg	2.2
NE_G,[3] Mcal/kg	1.8
CP	20.7
Acid detergent fiber	8.2
NFC[4]	50.8
Ether extract	4.9
Ash	5.6

[1]Ansymite (Afrand Tusca Co., Tehran, Iran) was a crystalline hydrated aluminosilicate containing 90% clinoptilolite with 67.2% SiO_2, 11.3% Al_2O_3, 1.5% K_2O, 1.8% Na_2O, 3.3% CaO, 0.8% MgO, 0.5% TiO_2, 0.06% MnO, 0.01% P_2O_5. The cation exchange capacity (CEC) = 170 to 200 mEq/100 g.

[2]Contained 250,000 IU of vitamin A, 50,000 IU of vitamin D, 1,500 IU of vitamin E, 2.25 g of Mn, 120 g of Ca, 7.7 g of Zn, 20 g of P, 20.5 g of Mg, 186 g of Na, 1.25 F, 3 g of S, 14 mg of Co, 1.25 g of Cu, 56 mg of I, and 10 mg of Se per kg of supplement.

[3]Calculated from NRC (2001).

[4]100 − (%NDF + %CP + % ether extract + %ash).

in a completely randomized design (within each sex), with repeated measures. Upon separation from dam, calves were transferred into individual hutches (1.5 × 1.12 × 1.2 m) bedded with clean wheat straw. The individual hutches were located outdoors, were made of metal and cement, and had an exercise area (1.2 × 2.1 m). The new bedding was added daily as much as required for individual hutches, and when necessary, was entirely cleaned and disinfected using sovlorin cetrimide-C (1.5% wt/vol clorohexidin glucoronate and 15% wt/vol cetrimide; Damloran Co., Boroojerd, Iran). The calves were fed colostrum and transition milk for 3 d at 10% of BW, and then were randomly assigned to 3 treatments. The treatments were feeding 1) whole milk (**M**), 2) 25% soymilk + 75% M (**S25**), or 3) 50% M + 50% soymilk (**S50**), at 10% of BW (wet basis). Calves were assigned to treatments such that each treatment had 3 female and 6 male calves. The treatments were offered twice daily at 1330 and 2030 h. Refrigerated soymilk was heated to 39 to 40°C before mixing with milk and delivering to the calves. The weaning criterion was defined as the calf age at a minimum daily starter intake of ≥900 g for 2 consecutive weeks, or additionally, as the calf age at a minimum BW of 70 kg. Calves had unlimited access to a starter concentrate (Table 1) and fresh water. The animals were cared for according to the guidelines of the Iranian Council of Animal Care (1995). This study was conducted at the calf raising facilities of the Lavark Research Station (Isfahan University of Technology, Isfahan, Iran) from August through November 2006. The average air temperature was 19.4 ± 8.2°C, and relative humidity was 42 ± 11% during the study.

Soymilk Production and Preparation

Soybeans were initially sifted, cleaned, and washed using regular water. The washed beans were soaked in deionized water for 18 h and were cooked by heating up to 98°C for 10 min. The cooked product was subsequently fractured and mixed with water using a homogenizer. The homogenate was centrifuged (model 5200 Pieralisi, Sambuca Val di Pesa, Italy) at 3,450 × *g* to extract soymilk and separate the major protein concentrate. The extracted soymilk was transferred into a storage tank and exposed to vacuum (640 mmHg) under steam pressure (2.5 to 3 mmHg). The resultant soymilk was deodorized, decontaminated, and finally pasteurized at 78°C before use.

On-Farm and Laboratory Measurements

Calves were weighed weekly shortly before the afternoon milk delivery. Feces were scored for physical shape and consistency with the scores of 1 = firm, 2 = slightly loose, 3 = loose, and 4 = watery. The daily amount of starter offered and orts were recorded for each calf and DM content was determined by oven-drying at 60°C for 48 h. Feed was sampled every 2 wk and analyzed for DM, ash (at 500°C overnight), NDF (Van Soest et al., 1991; using heat-stable alpha-amylase), and ADF (AOAC, 1997). Soymilk was analyzed for CP (Kjeltech, Auto 1030 Analyzer, Höganäs, Sweden), ether extract (AOAC, 1997), and DM (Freeze Drier FD–Amitamura Riken Kogoyo Inc., Ogawa Seiki Co. Ltd., Tokyo, Japan). Whole milk was analyzed for protein, fat, and solids using an infrared analyzer (Milk-O-Scan 133B, Foss Electric, Hillerød, Denmark). Whole milk and soymilk were also analyzed for calcium (titration method) and phosphorous (UV 2100–VIS Spectrophotometer Shimadzu, Kyoto, Japan). The DM, CP, total fat, ash, calcium, and phosphorous contents were, respectively, 12.0, 25.0, 33.3, 5.8, 1.0, and 0.8% for whole milk; and 9.8, 18.3, 0.5, 6.7, 1.0, and 0.20% for soymilk (DM basis).

Statistical Analysis

Data were analyzed as a linear mixed model using PROC MIXED of SAS Institute (SAS Institute Inc., 2003). Final models included the fixed effects of treatment and sex and the random effect of calf. For the