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# Short- and long-term effects of forage supplementation of calves during the preweaning period on performance, reproduction, and milk yield at first lactation

**Ll. Castells,* A. Bach,*† and M. Terré*[1]**
*Department of Ruminant Production, IRTA (Institut de Recerca i Tecnologia Agroalimentàries), 08140 Caldes de Montbui, Spain
†ICREA (Institució Catalana de Recerca i Estudis Avançats), 08010 Barcelona, Spain

## ABSTRACT

Sixty female Holstein calves [body weight (BW) = 39.5 ± 3.76 kg] were fed a ground starter concentrate [19% crude protein, 19% neutral detergent fiber (NDF)] during the preweaning period. Furthermore, oats hay (68% NDF) was supplemented only during the postweaning period (CON) or during both pre- and postweaning periods (OH) to evaluate performance until first breeding, diet digestibility after weaning, reproductive performance, and milk yield at first lactation. Calves were individually housed and bedded with wood shavings. All calves were offered 6 L/d of milk replacer (MR) at 12% dry matter (DM) in 2 feedings until 28 d of age, 3 L/d of MR at 12% DM in 2 feedings from 29 to 44 d of age calves, and 1.5 L of MR at 12% DM in 1 feeding from 45 to 51 d of age. Animals were weaned at 52 d of age. Starter concentrate and forage intake were recorded daily and BW weekly until 65 d of age. Two weeks after weaning, total-tract apparent digestibility was determined in 6 calves per treatment. Heifer BW was recorded at 10 mo of age. Breeding and milk yield at first lactation were also recorded. Starter concentrate intake was greater in OH compared with CON animals during the preweaning period. As a result, calves in the OH treatment had greater average daily gain (ADG) than CON animals during the preweaning period. After weaning, OH calves consumed more forage than CON animals, but we found no differences between treatments in ADG and starter concentrate intake. Similarly, total-tract apparent digestibility did not differ between treatments, and BW and ADG from 2 wk after weaning to 10 mo of age did not differ between treatments. Moreover, no differences in reproductive performance [age at first artificial insemination (AI), age at fertile insemination, conception rate at first AI, and number of AI] or milk yield at first lactation were observed between treatments, although a positive relationship between growth rate early in life and future energy-corrected milk yield was found. We conclude that offering forage to young calves early in life allows improvements in growth before weaning and could help in the transition to mixed diets, but the improvement in growth achieved early in life was not maintained at 10 mo of age.
**Key words:** forage, growth, heifer

## INTRODUCTION

The 2 most important goals for dairy producers regarding heifer rearing are (1) reducing age at first calving to diminish the net cost of raising replacement heifers (Tozer and Heinrichs, 2001) without impairing BW at calving to optimize milk yield at first lactation (Bach and Ahedo 2008), and (2) ensuring high milk yield at adulthood. Age at first calving (**AFC**) depends on age at first insemination and fertility, but deciding to inseminate heifers earlier to decrease AFC without considering their musculoskeletal development may negatively affect milk production at first lactation (Mohd Nor et al., 2013). Although decisions to start inseminating heifers should be based on BW or skeletal measurements (Le Cozler et al., 2008), in a survey done in the Netherlands, 60% of farmers indicated that they used age alone to determine the moment of first insemination (Mohd Nor et al., 2013).

Greater growth during the first 6 mo of life on UK farms has been associated with lower AFC (Brickell et al., 2009), and several studies (Moallem et al., 2010; Bach, 2012; Soberon et al., 2012) have reported that improved performance during the preweaning period can result in greater milk yield at first lactation. During the preweaning period, ADG can be improved by feeding high levels of milk or milk replacer (**MR**) to calves (Terré et al., 2007; Raeth-Knight et al., 2009), but the supplementation of forage in diets at low levels of MR also resulted in improved performance during this period (Castells et al., 2012). Therefore, some benefits of forage supplementation early in life may be envisaged later in life due to improved growth rate at a young

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[1]Corresponding author: marta.terre@irta.cat

age. The objective of the present study was to evaluate whether the expected improved performance early in life resulting from supplementing forage to young calves fed low volumes of MR has longer-term effects, potentially affecting reproductive performance, growth until 10 mo of age, and milk yield at first lactation.

## MATERIALS AND METHODS

### Animals and Treatments

Sixty female Holstein calves (initial BW 39.5 ± 3.76 kg and 6.7 ± 2.12 d of age) were individually housed in the facilities of the contract heifer operation Recria Segle XXI (Vilanant, Spain). Calves were randomly assigned to 1 of 2 dietary treatments according to age and BW. Dietary treatments consisted of a ground starter concentrate (Table 1) without any forage supplementation during the preweaning period and chopped oats hay (8% CP, 68% NDF) supplementation after weaning (**CON**), or the same starter concentrate plus supplementation of oats hay during the pre- and postweaning periods (**OH**). Forage was chopped using a forage chopper (Seko, Curtalo, Italy) to the following particle size distribution: 27.5% >20 mm, 26.2% 8–20 mm, and 46.2% <8 mm. Water was offered ad libitum throughout the study. Calves received 6 L/d of MR (23.7% CP and 20.1% fat; Celtilait, Ploudaniel, France) at 12% DM in 2 feedings until 28 d of age. From 29 to 44 d of age, calves were fed 3 L/d of MR at 12% DM in 2 feedings, and from d 45 to 51, calves were fed 1.5 L/d of MR at 12% DM in one feeding. Animals were weaned at 52 d of age. Calves were kept in individual pens until 2 wk after weaning; thereafter, animals were housed in groups of 30 to 40 animals per pen. From 2 wk after weaning to 3 mo of age, heifers were fed the same concentrate feed as during the pre- and postweaning periods plus forage, both offered ad libitum. From 3 mo of age to calving, heifers were fed a TMR based on triticale silage and concentrate. From 3 to 14 mo of age, the TMR contained 15.0% CP and 2.60 Mcal of ME/kg on a DM basis; from 15 mo of age to calving, the TMR contained 14.0% CP and 2.40 Mcal of ME/kg on a DM basis. Hip height was measured at 13.5 mo of age and those heifers with hip height >130 cm were inseminated when observed in estrus. Furthermore, heifers that were not observed in estrus at 13.8 mo of age were synchronized using a progesterone-releasing intravaginal device.

### Measurements and Chemical Analysis

Starter concentrate and forage intake were recorded daily and BW weekly until 65 d of age. Later, at 10 mo of age, BW was also recorded. Two weeks after weaning, total-tract apparent digestibility was determined in 6 calves per treatment following the method used by Castells et al. (2012). During 5 consecutive days, all feces were collected using plastic bags. Feces were weighed daily, and a 30% subsample was collected and dried at 60°C. Fecal samples were composite by each animal and analyzed for DM, CP, NDF, and ash. Furthermore, veterinary treatments during the preweaning period, breeding data (age at first AI, age at fertile insemination, and total number of AI per gestation), and milk yield at 305 DIM were also recorded.

**Table 1.** Ingredient and chemical composition (as % of DM) of experimental starter feed and forages

| Item | Value |
|---|---|
| Ingredient | |
| Corn meal | 41.9 |
| Barley meal | 19.0 |
| Soybean meal, 44% CP | 19.2 |
| Soybean hulls | 6.2 |
| Gluten feed | 2.8 |
| Sunflower meal | 4.4 |
| Carob | 4.0 |
| Palm oil | 0.3 |
| Premix[1] | 0.5 |
| Calcium carbonate | 1.0 |
| Sodium carbonate | 0.3 |
| Magnesium oxide | 0.2 |
| Sodium chloride | 0.2 |
| Chemical composition | |
| CP | 18.8 |
| NDF | 18.9 |
| ADF | 9.5 |
| Ether extract | 3.9 |
| Ash | 5.2 |

[1]Mineral and vitamin composition: vitamin A 2,000,000 IU/kg, vitamin $D_3$ 200,000 IU/kg, vitamin E 7,500 mg/kg, vitamin $B_1$ 500 mg/kg, vitamin $B_2$ 255 mg/kg, vitamin $B_6$ 147 mg/kg, vitamin $B_3$ 1,237.5 mg/kg, choline 17,980 mg/kg, ferrous sulfate 7,515 mg/kg, zinc oxide 10,000 mg/kg, cupric sulfate 2,510 mg/kg, manganese oxide 12,500 mg/kg, cobalt 100 mg/kg, potassium iodide 105 mg/kg, sodium selenite 50 mg/kg, and magnesium oxide 40,000 mg/kg.

Samples of MR, starter concentrate, and feces were analyzed for DM (24 h at 103°C), ash (4 h at 550°C), and N content using the AOAC (1990; method no 988.05) adapted for an automatic distiller Kjeldahl (Kjeltec Auto 1030 Analyzer, Tecator, Höganäs, Sweden) and using $CuSO_4$/Se as a catalyst instead of $CuSO_4$/$TiO_2$, NDF, and ADF, with sodium sulfite and heat-stable α-amylase (Van Soest et al., 1991).

### Statistical Analysis

Calf performance data were split into the preweaning period (from 10 to 51 d of age) and the postweaning period (from 52 to 65 d of age) and were analyzed using a mixed-effects model with repeated measures with the auto-regressive variance-covariance structure. The