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Effect of different management systems on growth, endocrine parameters and puberty in Hereford female calves grazing Campos grassland

D. Guggeri [a], A. Meikle [b], M. Carriquiry [c], F. Montossi [a], I. De Barbieri [a], C. Viñoles [a,*]

[a] INIA, Instituto Nacional de Investigación Agropecuaria, Route 5, km 386, Tacuarembó 45000, Uruguay
[b] Laboratory of Nuclear Techniques, Veterinary Faculty, Alberto Lasplaces 1550, Montevideo 11600, Uruguay
[c] Animal and Pastures Production, Agronomy Faculty, Garzón 780, Montevideo 12900, Uruguay

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ABSTRACT

This study compared different management systems applied early in life on body development, endocrine parameters and age at puberty in beef heifers grazing Campos grassland, from 75 to 539 ± 1.5 days of age. Calves were allocated to three treatments: (1) Early weaning (EW, $n=15$) at 75 ± 1.5 days of age; (2) Traditional weaning (TW, $n=14$) at 158 ± 1.5 days of age; (3) Traditional weaning plus creep feeding (TW+CF, $n=17$). Early weaned and TW+CF calves received a supplement that supplied 26 ± 1.1% of crude protein and 11.7 ± 0.04 MJ ME/kg DM from 75 to 158 ± 1.5 days. Traditional weaned calves had a greater average daily weight gain (0.86 ± 0.03 kg/day; ADWG) than EW calves (0.75 ± 0.03 kg/day) from 75 to 158 ± 1.5 days, associated with greater IGF-I concentrations at the time of TW (112.9 ± 10.7 and 63.4 ± 10.3 ng/mL respectively; $P<0.05$) that had no impact on age at puberty. Traditional weaning plus CF calves had a superior ADWG from 75 to 158 ± 1.5 days (1.25 ± 0.03 kg/day; $P<0.05$), greater concentrations of IGF-I at weaning (185.3 ± 9.6 ng/mL), were heavier and taller ($P<0.02$) from weaning to 539 ± 1.5 days, and puberty occurred earlier (472 ± 8.0 days of age) than EW (526 ± 7.2 days of age; $P<0.05$) and tended to occur earlier than TW calves (484 ± 3.4 days of age; $P=0.06$). We conclude that age at weaning had a short-term impact on body growth and IGF-I concentrations, that had no effects on the age at puberty. However, CF induced a faster body development, which was related to an earlier attainment of puberty.

1. Introduction

Age at puberty and age at first calving affect cow lifetime productivity (Lesmeister et al., 1973). Less average daily weight gains before weaning and lesser weaning weights are associated with a delay in the age at puberty in beef cattle (Arije and Wiltbank, 1971). In extensive rangeland cow–calf systems, variability in quantity and quality of pastures during the summer and winter (Berretta et al., 2000), limits the energy and protein intake of calves and impacts negatively on their pre- and post-weaning growth rate (Viñoles et al., 2009). Early weaning plus feeding a greater concentrate diet and creep feeding nursing calves are two management strategies that can be imposed to overcome the food shortage to increase weaning weights (Halloway and Totusek, 1973; Neville and McCormick, 1981) and advance age at puberty.

* Corresponding author. Tel./fax: +598 46322407.
E-mail address: cvinoles@adinet.com.uy (C. Viñoles).

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There is a large amount of information on the impact of different management strategies on the growth and development of calves with results being inconsistent. Richardson et al. (1978) found that early-weaned calves were heavier than traditional weaned calves, while Halloway and Totusek (1973) and de Castro et al. (2004) found that early weaned calves were lighter than traditional weaned calves by the time of traditional weaning and up to 305 days of age. However, Gasser et al. (2006) found that early-weaned calves fed a high-energy diet had average daily weight gains greater than 1 kg/day, and reached live weights greater than 300 kg before 400 days of age. These conflicting results may be explained by the different nutritional regimens imposed on calves. By contrast, the literature on the effect of creep feeding calves weaned at a traditional age consistently supports a superior average daily weight gain and greater weaning weights of creep fed compared with non-creep fed counterparts (Faulkner et al., 1994; Loy et al., 2002). Greater nutritional regimens early in life are positively associated with the metabolic status that stimulates growth of bone and muscle and the rate of fat deposition (Hopper et al., 1993; Hall et al., 1995) that can influence their subsequent lifetime reproductive performance (Gunn et al., 1995).

Heifers reach puberty at a consistent proportion of their projected mature body weight (Freetly et al., 2011), which is associated with the concentrations of insulin-like growth factor-I (IGF-I), insulin, glucose and leptin, that signal directly or indirectly in the hypothalamic neurons (Straus, 1984; Stevens et al., 1990; Kiess et al., 1998; Laron, 2001; Brito et al., 2007). Early weaned calves reach puberty at the same age as traditional weaned calves (600 days of age; de Castro et al., 2004), but precocious puberty can be induced if early weaned calves are feed a diet high in concentrates (less than 300 days; Gasser et al., 2006). Although it is well established that the somatotrophic axis, metabolic hormones and metabolites are involved in tissue growth and sexual maturity, there is a lack of information of the impact of different management systems on these parameters (Loy et al., 2002).

We hypothesized that a management system that stimulates greater rates of gain early in life, will stimulate an increase in the concentrations of metabolic hormones, accelerate body growth and development and determine an earlier attainment of puberty in beef heifers.

Thus, the objective of this study was to compare groups of calves that were early weaned with calves that were traditional weaned with or without a supplementation rich in energy/protein during lactation, on growth and development, endocrine parameters and age at puberty.

2. Materials and methods

Animal experimentation was in compliance with regulations set by the Ethical Committee of the University of Uruguay (Montevideo, Uruguay) and is in accordance with EU Directive 2010/63/EU for animal experiments.

2.1. Location and calves management

The experiment was conducted at the "Glencoe" Research Station of the "Instituto Nacional de Investigación Agropecuaria" (INIA Tacuarembó), Paysandú, Uruguay (S31° W42°), from the first summer to the second autumn of calve's life.

The experiment involved 46 Hereford female calves (daughters of multiparous cows) born in spring (September–November) in a randomized block design with two replications. At 75 ± 1.5 days of age (range: 60–90 days; least square means ± pooled standard error) and 79.4 ± 2.9 kg of body weight, calves were blocked by date of birth and birth weight into three experimental groups: (1) "Early weaning" (EW; $n=15$); calves weaned at 75 ± 1.5 days of age that received a supplement, from 75 to 158 ± 1.5 days (Period I) at a rate of 1.5% body weight; (2) "Traditional weaning" (TW; $n=14$; control treatment), calves weaned at 158 ± 1.5 days old (3) "Traditional weaning plus creep-feeding" (TW+CF, $n=17$), calves weaned at 158 ± 1.5 days of age that received a supplement from 75 to 158 ± 1.5 days at a rate of 1.3% body weight. The three experimental groups grazed Campos grassland (Allen et al., 2011) and the forage allowance and the chemical composition of the pasture did not differ between treatments and was 4.0 ± 0.6 kg dry matter (DM)/kg body weight (Sollenberger et al., 2005) and 8.7 ± 0.3% crude protein, 7.9 ± 0.04 MJ metabolizable energy (ME)/kg dry matter (DM) respectively. The supplement used in Period I supplied 26 ± 1.1% of crude protein and 11.7 ± 0.04 MJ ME/kg DM (Ternero 1 Premium, Colonia el Ombú, Río Negro, Uruguay).

From 158 to 539 ± 1.5 days of age (Period II), all calves were managed under the same nutritional conditions and grazed immediately after traditional weaning a native pasture with a greater forage allowance (28 kg DM/kg body weight) and then a native pasture improved with white clover and lotus at a mean forage allowance of 3.9 ± 0.8 kg DM/kg body weight. Season variations in forage availability and forage allowance during Period II are presented in Fig. 1. The mean chemical composition of the pasture was 9.6 ± 0.4% crude protein and 8.6 ± 0.13 MJ ME/kg DM. All animals received a supplement from 435 to 539 ± 1.5 days of age that supplied 14.4 ± 0.5% crude protein and 12.1 ± 0.08 MJ ME/kg DM at a rate of 1% body weight.

2.2. Growth and development variables

Body weight was measured every 14 days, from 75 to 539 ± 1.5 days of age (scale True-test GR 3000®, True-test Corporation Limited, Montevideo, Uruguay) and hip height was measured every 56 days from 158 to 539 ± 1.5 days of age, with a ruler at the point directly above the hipbones, with the animal standing on a level surface. The data obtained were used to calculate average daily weight gain and growth respectively.

Back fat thickness (subcutaneous fat over the longissimus dorsi muscle between the 12th and 13th rib, measured in mm), marbling (percentage of intramuscular fat inside the longissimus dorsi muscle; measure in percentage), rib eye area (area of the longissimus dorsi muscle measured in cm^2) and fat thickness at the rump (subcutaneous rump fat depth at the p8 site, which is located over the gluteus muscle on the rump, at the intersection of

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