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Colostrum composition of Santa Inês sheep and passive transfer of immunity to lambs

A. C. Alves,*[1] N. G. Alves,*† I. J. Ascari,* F. B. Junqueira,† A. S. Coutinho,* R. R. Lima,‡ J. R. O. Pérez,† S. O. De Paula,§ I. F. Furusho-Garcia,† and L. R. Abreu#
*Department of Veterinary Medicine,
†Department of Animal Science, and
‡Department of Exact Sciences, Federal University of Lavras, Lavras, 37200-000, Minas Gerais, Brazil
§Department of General Biology, Federal University of Viçosa, Viçosa, 36571-000, Minas Gerais, Brazil
#Department of Food Sciences, Federal University of Lavras, Lavras, 37200-000, Minas Gerais, Brazil

ABSTRACT

This study aimed to analyze the chemical composition and the IgG concentration of the colostrum, transitional milk, and mature milk of Santa Inês ewes as well as the transfer of passive immunity to lambs. Thirty-two pregnant ewes and 38 lambs were used. Ewes were milked immediately after lambing and at 12, 24, 36 h and 10 d postpartum. Colostrum was provided to the lambs at 40 ± 15 min (mean ± SE) after birth and then at 30-min intervals for obtaining the intake closest to 10% of body weight, and transitional milk was provided ad libitum. Blood from the lambs was collected 36 h after birth for measuring the serum concentrations of IgG, total protein, albumin, and gamma-globulin. The production was lower in primiparous than in multiparous ewes with body condition score (BCS) < 2.75, but did not differ between primiparous and multiparous with BCS ≥ 2.75 (interaction parity and BCS). The IgG concentration and fat, protein, lactose, and defatted dry extract percentages were not affected by the BCS of the ewe at lambing or by the parity. The total solids percentage in the colostrum was higher in ewes with BCS <2.75 (interaction BCS and time). The production and the protein, total solid, and defatted dry extract percentages showed quadratic behavior, the fat percentage decreased linearly, and the lactose percentage increased linearly with time postpartum. The IgG concentration in the colostrum was not correlated with the ewe's weight or BCS at the time of lambing. Moreover, the parity, the BCS, the ewe's type of gestation, and the lamb's sex did not influence the serum concentrations of IgG, total protein, albumin, and gamma-globulin in lambs. Adequate passive immune transfer (PIT) was observed in lambs for which the IgG intake was higher than 30 g. Failure in PIT was observed in 39.5% of lambs when considering a serum IgG concentration lower than 15 mg/mL and in 21% when considering a serum total protein concentration lower than 45 mg/mL. The mean apparent efficiency of absorption was 38.10%, with values between 0.02% and 98.80%. The serum IgG concentration was correlated with the total protein concentration (according to the enzymatic colorimetric method), the gamma-globulin concentration, and the absorption efficiency. The extreme variation on apparent efficiency of absorption may have an effect on the success of PIT. Lambs should consume at least 30 g of IgG in the first 24 h of life to ensure adequate PIT.

Key words: ELISA, gamma-globulin, immunoglobulin G, total serum protein

INTRODUCTION

In ruminants, colostrum is the sole source of initial acquired immunity for the offspring (Stelwagen et al., 2009), with IgG being the major immunoglobulin class present, which ensures protection in early life (Larson et al., 1980). However, the increased abomasal secretions and proteolytic activity of the intestinal mucosa (Kruse, 1983; Bessi et al., 2002), as well as the reduced ability of the cells of the small intestine to absorb immunoglobulin (Quigley, 2001), result in a linear reduction of the IgG absorption efficiency after birth (Kruse, 1970). In fact, the cells of the small intestine in ruminants are able to internalize and transfer colostrum IgG in its intact form to the blood only during the first 24 h of life (Stott et al., 1979b; Sheldrake and Husband, 1985; Castro-Alonso et al., 2008).

Thus, colostrum should be provided within the shortest time possible after birth to ensure the adequate passive immune transfer (**PIT**) to lambs. Mellor and Murray (1986) recommended an intake of 180 to 210 mL of colostrum/kg of BW for lambs born in feedlots or the field during the first 18 h of life. According to

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[1]Corresponding author: nadja@dzo.ufla.br

Morrical et al. (1995), lambs should receive 10% of their BW in colostrum within 24 h after birth.

Passive immune transfer can be assessed through the serum total protein concentration, which reflects the amount of albumin and globulins, although this technique is nonspecific (Flaiban et al., 2009). The confirmatory tests considered the gold standard for IgG measurement include single radial immunodiffusion and ELISA. Enzyme-linked immunosorbent assay offers advantages in terms of cost, time, and ability to quantify the IgG level in a large number of samples at once, and this approach has been used to confirm the diagnosis of failure of PIT (**FPIT**) in cattle (Weaver et al., 2000; Hurley et al., 2004; Lee et al., 2008). Some authors (McGuire et al., 1983) used reference values in calves to characterize FPIT in lambs, whereas other authors (Hunter et al., 1977; Flaiban et al., 2009; Silva et al., 2009; Turquino et al., 2011) characterized FPIT by serum IgG concentration <15 mg/mL. However, no IgG value is universally accepted to characterize FPIT in lambs.

The colostrum and milk composition varies between sheep breeds. Colostral IgG concentration measured by single radial immunodiffusion varied from 60 to 70 mg/mL in ewes Rambouillet, Targhee, Columbia, and Finn crossbreed (Gilbert et al., 1988), Akkaraman (Maden et al., 2003), and Aragonesa (Loste et al., 2008), while was 79 mg/mL in the Polypay breed (al-Sabbagh et al., 1995) and 125 mg/mL in the Karakul breed (Hashemi et al., 2008). In the Santa Inês breed, which formed the basis of commercial flocks in Brazil, where they are mainly used for meat production, IgG values measured by radial immunodiffusion were 89.6 and 95.6 mg/mL in the colostrum from multiparous and primiparous ewes, respectively (Nunes, 2006). In addition, levels of 5.8% fat, 17.4% TS, and 11.6% defatted dry extract were found in the milk of this breed (Ribeiro et al., 2007).

The objectives of this study were to analyze the chemical composition and the IgG concentration of the colostrum, transitional milk, and mature milk of Santa Inês ewes and to evaluate the PIT to lambs through analysis of serum IgG and total protein concentrations at 36 h after birth.

MATERIALS AND METHODS

These experiments were performed at the Sheep Husbandry Sector of the Department of Animal Science, Federal University of Lavras (Universidade Federal de Lavras, UFLA), Lavras, Minas Gerais, Brazil. This research site is located at 21°14′43″S, 44°59′59″W, and altitude of 919 m. The project was approved by the Ethics Committee on Animal Use of UFLA and was registered under protocol number CEUA/UFLA 042/10.

Animals

Thirty-two Santa Inês sheep between the ages of 1 to 3 yr, with a weight of 53.3 ± 1.7 kg (mean ± SE) and BCS between 3.0 and 3.5 (scale 0–5, where 0 = emaciated and 5 = very fat; Gordon, 1997), were used to assess the colostrum and milk composition. From the 38 lambs used to evaluate PIT, 21 were from single and 17 from twin pregnancies. One of the lambs from a twin pregnancy was not included in the sampling because it had a low birth weight (1.690 kg) and dyspnea, followed by prostration; therefore, adequate colostrum feeding and blood collection were not possible.

Sheep Dietary Management

In the first 4 mo of pregnancy, the ewes were released in a *Brachiaria decumbens* pasture during the day (0700 to 1700 h) and were housed during the night (between 1700 and 0700 h) in collective pens. Their diet was supplemented with corn silage and concentrate containing soybean meal, corn meal, and minerals; mineral salt was provided ad libitum.

The ewes were confined in a collective stall for the last month of pregnancy and in individual stalls after lambing (1.0 × 2.7 m). The sheep were fed a complete diet (Table 1), twice a day, in a sufficient amount to allow at least 10% leftovers. The leftovers were weighed daily to adjust the amount offered. The diets were prepared according to the recommendations of the NRC (2007) to meet the nutritional requirements of sheep in late pregnancy or early lactation.

Milking

The ewes were separated from their lambs and milked after birth. An appropriate milking parlor was used, and 5 IU of oxytocin (Oxytocin Forte UCB, Uzinas Chimicas Brasileiras, Jaboticabal, Brazil) was administered intramuscularly to the sheep. The udder was completely milked after disinfection with 5% iodine solution.

Lambs from 2 ewes were suckled before the first milking, and the colostrum samples from these sheep were not analyzed. The lambs were confined in a small fenced area (1.0 × 0.5 m) inside the sheep stall for the first 36 h after birth to prevent access to the udder, thus enabling the milking of transitional milk. In total, 19, 17, and 20 samples of transitional milk milked at 12, 24, and 36 h after birth, respectively, were analyzed. The transitional milk from ewes whose lambs suckled