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Effects of newborn characteristics and length of colostrum feeding period on passive immune transfer in goat kids

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ABSTRACT

Majorera goat kids (n = 200) were used to evaluate the effects of litter size, birth body weight, sex, and suckling duration on serum IgG concentrations. Kids were assigned to 1 of 3 experimental groups: litter size and sex were equally distributed in each group. In the first group, kids (n = 67) stayed with their dams for 24 h; in the second group, kids (n = 66) stayed with their dams for 48 h; and in the third group, kids (n = 67) stayed with their dams for 120 h. Blood samples were obtained every 24 h for 5 d, and serum IgG concentration was measured using radial immunodiffusion. In litter sizes of 1 to 2 kids, IgG blood serum concentration was significantly higher (18.30 ± 5.40 mg/mL) than in litters of 3 kids (9.85 ± 4.23 mg/mL). Kid sex did not affect IgG blood serum concentrations. Suckling duration did not affect kid serum IgG concentrations. In conclusion, kids with low birth body weight (<2.8 kg) or from litters of 3 may need special attention. If newborn goat kids are allowed to suckle colostrum for at least 24 h from their dams, this seems to be sufficient time to ingest enough IgG from colostrum to achieve an adequate serum IgG concentration and passive immune protection to avoid failure of passive immune transfer.
Key words: goat kid, birth weight, litter size, immune passive transfer

INTRODUCTION

Ruminant placenta impedes the transfer of Ig from the dam to the fetus. Constant et al. (1994) asserted that goat kids are agammaglobulinemic at birth; however, Guerrault (1990), Rabbani et al. (1990), and Sherman et al. (1990) are all of the opinion that low serum IgG concentrations are present at birth. Consequently, the consumption of colostrum by the progeny of these species (cow, sheep, and goat) has a fundamental role in the acquisition of passive immunity (Lascelles, 1979).

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Some factors may directly affect the passive immune status of young ruminants, such as birth BW, litter size, sex, suckling duration, colostrum quantity, colostrum quality, and delay in colostrum feeding. Many of these factors have been previously studied in goat kids (Argüello et al., 2004; Castro et al., 2005, 2007), whereas others, such as birth BW, litter size, sex, and suckling duration have not yet been closely examined.

Chen et al. (1999) reported a peak blood serum IgG concentration of 33 mg/mL 24 h after birth following ingestion of colostrum. O'Brien and Sherman (1993) have defined failure of passive transfer (**FPT**) in the goat kid as a serum IgG concentration of <12 mg/mL using a spectrophotometric zinc sulfate turbidity assay. In addition, Argüello et al. (2004) found an IgG blood concentration of <5 mg/mL at 48 h postpartum in kids dying during the first month of life.

Castro et al. (2007) reported no significant effects of birth BW on IgG blood serum concentrations in kids, but there was a tendency for IgG concentrations to increase when the birth BW was between 2.5 and 3.2 kg. Chen et al. (1999) observed lower concentrations of IgG in the blood of single-born kids than for twins. O'Brien and Sherman (1993) and Chen et al. (1999) observed no significant relationship between kid sex and serum IgG concentrations after the ingestion of colostrum.

Previous research (Argüello et al., 2004; Castro et al., 2005, 2007) recommended the removal of kids from their dam at birth in dairy goat herds for 2 main reasons: to prevent a strong mother-kid link (Ramírez et al., 1996) and to reduce the risk of viral transmission by colostrum of caprine arthritis encephalitis virus (Guerrault, 1990). However, some farmers are still reluctant to remove kids at birth and allow the kids to stay with their dams for a few days postpartum to permit prolonged ingestion of colostrum. It is not clear how much time is necessary for goat kids to stay with their dams to provide sufficient passive transfer of immunity. The aim of the present study was to evaluate the effect of litter size, birth BW, sex, and duration of colostrum feeding on IgG blood serum concentrations during the first 5 d of life.

Table 1. Kid distribution in the different experimental groups

Colostrum suckling, d	Single kid		Twins		Triplets		
	Male	Female	Male	Female	Male	Female	Total kids
1	12	11	11	11	10	12	67
2	11	11	11	11	11	11	66
3	12	10	11	11	11	12	67

MATERIALS AND METHODS

This study was carried out at the experimental farm of the Faculty of Veterinary Studies of the University of Las Palmas de Gran Canaria (Gran Canaria, Spain). The experimental procedures were approved by the Las Palmas de Gran Canaria University ethical committee. Majorera kids (n = 200) were born from permanently sheltered and intensively fed doe goats. Goats were supervised from 0800 to 2300 h during the parturition season (from January to December). Only kids born during directly supervised parturitions were included in the study. Two hundred newborn Majorera kids were allocated in 3 equilibrated groups according to litter size (1, 2, or 3 kids) and sex (male or female) to which the experimental treatments were randomly assigned immediately after birth (Table 1). In the first group, kids (n = 67) remained with their dams for 1 d; in the second group, kids (n = 66) stayed with their dams for 2 d; and in the third group, kids (n = 67) stayed with their dams for 5 d. Kids were weighed, ear tagged, and navels were disinfected after birth.

Blood samples (3 mL) were obtained from each kid at birth by jugular venipuncture. Sampling was repeated at 24-h intervals until 120 h of age. Blood was centrifuged at 1,300 × *g* for 5 min at 4°C. Serum was divided into 2 aliquots and stored at –20°C until IgG analysis. Serum IgG concentration was determined using the radial immunodiffusion method described by Mancini et al. (1965) modified by Castro et al. (2005).

A general linear model PROC MIXED procedure was performed to evaluate the effects of litter size, birth BW, sex, and suckling duration on IgG blood serum concentration and on interactions between the main variation factors. After that, a Tukey's test was performed ($P < 0.05$). Statistical analysis was performed using SAS software (v. 9.0, SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSION

The IgG blood serum concentration through the first 5 d of life according to litter size is shown in Table 2. Mean IgG blood serum concentrations for kids of 1- and 2-kid litters ranged from 15.5 to 23.1 mg/mL, which was greater ($P < 0.05$) than those of kids from 3-kid litters, which had values ranging from 6.2 to 16.3 mg/mL. The IgG concentrations in kids from litter sizes of 1 and 2 kids were closer to that reported by Argüello et al. (2004) for the same breed with similar management, and were well above the FPT IgG serum concentration threshold. On the contrary, kids from litters of 3 kids showed IgG concentrations indicative of FPT at 1, 3, 4, and 5 d post-birth (O'Brien and Sherman, 1993). These IgG concentration differences between litter sizes 1 or 2 and 3 may arise for 2 main reasons: low colostrum production or low colostrum intake. Low colostrum production most likely affects nondairy breeds; the Majorera breed usually produces more than 2 L of colostrum in the first 24 h postpartum (A. Argüello, unpublished data) with a mean IgG blood serum concentration of 35 mg/mL (Argüello et al., 2006). The total IgG produced during 24 h is thus approximately 70 g. Castro et al. (2005) reported that 4 g of IgG per kg of BW was sufficient to avoid FPT. Based on these data, 2 L of colostrum with an IgG blood serum concentration of 35 mg/mL would be sufficient for 17.5 kg of neonate BW. The second hypothesis was more suitable to explain the results shown in Table 1. In addition, Castro et al. (2005) reported low IgG blood concentrations in animals in 3-kid litters because access to teats was more difficult for them than for kids in 1- or 2-kid litters. Ramírez et al. (1998) also showed that twin kids of Murciano-Granadina breed took longer for first stand up than single kids. A third possibility is that kids from a litter of 3 usually present lower birth BW than kids from litter sizes of 1 or 2 (Fabelo et al., 1992), which might limit gut size and thus feed intake capacity, lowering the amount of ingested colostrum. Bekele et al. (1992) did not find differences between single and twin lambs from the Ethiopian Menz breed. These results are similar to those shown in Table 2 for single or twin kids, but differences were found with triplets.

Table 2 shows the mean IgG blood serum concentrations dependent on birth BW. Kids with a birth BW ranging from 2.8 to 3.3 kg and 3.3 to 4.2 kg presented significantly higher IgG blood serum concentrations throughout the experiment than kids with birth BW between 1.7 to 2.8 kg. Immunoglobulin G blood serum