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The effect of colostrum source (goat vs. sheep) and timing of the first colostrum feeding (2 h vs. 14 h after birth) on body weight and immune status of artificially reared newborn lambs

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ABSTRACT

Several factors can affect lamb body weight (BW) and immune status during the first days of life, including colostrum source and timing of the first colostrum feeding. The aim of this study was to evaluate the effects of colostrum source (goat or sheep) and timing of the first colostrum feeding (2 or 14 h after birth) on lamb BW and immune status. In this study, 40 lambs were removed from their dams at birth and randomly assigned into 4 groups of 10 lambs each. Lambs were subsequently fed at 2 or 14 h after birth with goat or sheep colostrum. Blood samples and BW recording were performed before feeding. Blood plasma was used to measure the immunoglobulin concentration (IgG and IgM), chitotriosidase activity, and complement system activity (total and alternative pathways). In general, no differences in any of the measured variables were observed among the 4 groups, indicating that neither colostrum source nor timing of the first colostrum feeding had an effect on these variables. These findings may improve management on lamb farms that raise animals under artificial conditions, because our results indicate that it is not necessary to feed colostrum to lambs immediately after birth and that goat colostrum may be used to feed newborn lambs.
Key words: chitotriosidase, lamb, goat colostrum, complement system

INTRODUCTION

Newborn ruminants have 3 critical periods related to their immune system development during the first 2 mo of life: colostrum feeding, milk feeding, and weaning. Management in these periods affects final animal performance (Marsico et al., 1993; Massimini et al., 2007; Mastellone et al., 2011).

The importance of small dairy ruminants has increased significantly recent years (Lérias et al., 2013; Morales-delaNuez et al., 2014). Today, the number of high-production dairy sheep farms is increasing worldwide, but especially in developing countries (Lérias et al., 2014), where lambs are reared under an artificial feeding system to increase production of marketable sheep milk. Under this system, lambs are separated from their dams at an early age and then fed colostrum and milk replacer to increase the amount of milk available for processing into dairy products such as cheese or yogurt (Demiroren et al., 1995; Napolitano et al., 2008). Separating lambs from their dams early also simplifies their management (Emsen et al., 2004).

The consumption of colostrum by the progeny of ruminant species (cow, sheep, and goat) has a fundamental role in passive immune transfer and in the survival rate of newborns (Lascelles, 1979; Stelwagen et al., 2009; Hernández-Castellano et al., 2014a), as they are born hypo-gammaglobulinemic. For this reason, animals growing under an artificial rearing system need to be fed, by bottle, an adequate amount of colostrum during their first days of life, to obtain adequate passive immune transfer and increase future productivity (Morales-delaNuez et al., 2011). Nevertheless, the amount of colostrum produced by the dam and its composition can be affected by several factors such as nutrition or litter size (Banchero et al., 2004). In addition, lambs fed an inadequate amount of colostrum in the first hours of life are more susceptible to disease and mortality (Ahmad et al., 2000; da Nobrega et al., 2005; Nowak and Poindron, 2006). Therefore, it is crucial to

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provide an optimal colostrum source, and consequently, several studies have investigated the use of bovine colostrum as an alternative source to feed lambs in early life (Quigley et al., 2002; Moretti et al., 2010). However, studies report that lambs fed with cow colostrum run the risk of developing anemia (Winter and Clarkson, 1992; Winter, 2011; Ruby et al., 2012). For this reason, it is necessary to study another colostrum source from a phylogenetically closer species, such as goat, which may provide similar passive immune transfer to sheep colostrum and therefore would not affect the future performance of the offspring.

Timing of the first colostrum feeding (**TFCF**) is another important factor that affects immune status and, therefore, the future productivity of adult animals (Hernández-Castellano et al., 2014b). For ruminants, the period between 12 and 36 h after birth is critical for absorption of colostrum IgG (Chen et al., 1999; Nowak and Poindron, 2006; Castro-Alonso et al., 2008) to acquire an adequate initial immunoglobulin concentration in blood (O'Doherty and Crosby, 1997; Quigley et al., 2000; Christley et al., 2003). Nevertheless, it is necessary to study how a delay in TFCF could affect the final immune status in the lamb's bloodstream, as this could affect the future performance.

One of the most important immune variables is the immunoglobulin concentration (mainly IgG and IgM). However, other immune variables directly affect lamb immune status, such as chitotriosidase (**ChT**) activity and complement system activity, and play an important role in the final animal productivity. As described by Argüello et al. (2008), ChT is an important component of innate immunity against chitin-containing pathogens. Chitotriosidase is a functional chitinase with a high homology to chitinases that belong to family 18 of glycosyl hydrolases. Although research on chitotriosidase has been undertaken in humans (Musumeci et al., 2005) and goats (Argüello et al., 2008; Hernández-Castellano et al., 2011; Moreno-Indias et al., 2012b), this enzyme has never been described in sheep or lambs. Chitotriosidase is predominantly a secretory protein that is expressed only in the late stage of monocyte differentiation and it is capable of hydrolyzing chitin in the cell wall of fungi and nematodes (Barone et al., 1999).

Complement system activity—comprising the total (**TCA**) and alternative (**ACA**) pathways—plays an important role in host defense mechanisms against infectious microbes, because it is involved in specific and nonspecific immunity (Rodríguez et al., 2009). The complement system in mammals has been well described, particularly in humans and mice as well as in cows and goats (Castro et al., 2008; Mayilyan et al., 2008; Rodríguez et al., 2009; Moreno-Indias et al., 2012a). However, few studies have described complement system activity in sheep and lambs (Oswald et al., 1990).

The aim of this study was to determine the evolution of BW and immune status (IgG and IgM concentrations, ChT activity, and complement system activity) at d 0, 1, 2, 3, 4, 5, and 20 after birth in relation to colostrum source (goat vs. sheep) and TFCF (2 vs. 14 h after birth).

MATERIALS AND METHODS

The study was performed in the Department of Animal Science of the Universidad de Las Palmas de Gran Canaria, Canary Islands (Spain) on 40 lambs (20 males and 20 females) of the Canary dairy breed. Animal procedures were approved by the ethical committee of the university.

Colostrum-Feeding Period

At birth, 40 singleton lambs were removed from their dams. Because dams underwent estrous synchronization and were subsequently mated, all lambs were born over a few days in the same period (May 2013).

During the first 2 h after birth, lambs were dried, weighed, and ear tagged. Thereafter, lambs were equally divided by sex and then randomly divided into 4 groups with 10 lambs each (5 males and 5 females) based on the method of colostrum feeding and without contact with the dam. Goat colostrum 2 h (**GC2**) and goat colostrum 14 h (**GC14**) groups received a goat colostrum pool (41 mg of IgG/mL of colostrum) that was previously pasteurized at 63°C for 30 min according to Trujillo et al. (2007). Sheep colostrum 2 h (**SC2**) and sheep colostrum 14 h (**SC14**) groups received a sheep colostrum pool (65 mg of IgG/mL of colostrum) that was pasteurized by the procedure previously described. The timing of the first meal of colostrum is critical because optimal absorption of immunoglobulins occurs before 4 h of life and decreases rapidly after 12 h after birth (Vasseur et al., 2010). Therefore, lambs from GC2 and SC2 were bottle-fed colostrum at 2, 14, and 24 h after birth, whereas GC14 and SC14 lambs were only bottle-fed colostrum at 14 and 24 h after birth. Because no recommendation about the requirements of colostrum (IgG/kg of BW) in artificially reared lambs was found in the literature, all lambs used in this study received a total colostrum amount equivalent to 4 g of IgG/kg of BW during the colostrum period (24 h after birth), according to the recommended concentration for goat kids (Castro et al., 2005). All pens used in this study were equipped to maintain room temperature

at 20°C with a central heating system and provided at least 0.3 m^2 of floor space per lamb. During the colostrum period, lambs were placed in a common pen.

After the colostrum period, the artificial rearing groups (GC2, GC14, SC2, and SC14) were moved to a pen, one per treatment (10 lambs per group) and received a commercial milk replacer at 16% (wt/wt, Bacilactol Corderos y Cabritos, Saprogal, La Coruña, Spain; 95.5% DM, 23.6% CP, and 22.7% ether extract, air-dry powder basis). These groups were fed ad libitum (milk replacer temperature: 37°C), using nipple buckets twice a day (0800 and 1700 h). Milk replacer was offered to lambs until refusal and the volume of the remainder was used to calculate intake.

BW Recording and Sample Collection

All experimental animals were weighed before taking the blood samples, and BW was expressed in kilograms (MOBBA, Barcelona, Spain; accuracy, 5 g). Blood samples were collected before the morning feeding from the jugular vein in 2.5-mL K-EDTA tubes. Blood was centrifuged at 2,190 × *g* for 5 min at 4°C (Universal 32 R, Hettich-Zentrifugen, Tuttlingen, Germany), and the obtained plasma was stored at −80°C until analysis. During the experimental period, blood samples were taken at 2 h after birth (labeled as sample 0) and then at 1, 2, 3, 4, 5, and 20 d after birth.

Clinical Pathology

The goat and sheep colostrum IgG concentrations (41 and 65 mg/mL, respectively) were determined using commercial ELISA kits (Bethyl Laboratories, Montgomery, TX). To determine blood plasma IgG and IgM concentrations, commercial ELISA kits (Bethyl Laboratories) were used, with purified sheep IgG and IgM as standard references. Results were expressed as milligrams of immunoglobulin per milliliter of plasma. Samples were individually analyzed in triplicate and a valid result was considered when differences between them were less than 10%.

Chitotriosidase activity was measured following a procedure described previously by Argüello et al. (2008) in goat blood plasma. In this procedure, 1 μL of undiluted blood plasma was mixed with 100 μL of a solution containing 22 m*M* artificial substrate (4-methylumbelliferyl-D-*N*,*N*′,*N*″-triacetylchitotriose) in 0.5 *M* citrate phosphate buffer (pH 5.2) and then incubated for 15 min at 37°C. The reaction was stopped with 5 mL of 0.5 *M* Na_2CO_3-$NaHCO_3$ buffer (pH 10.7). Fluorescence was measured using a fluorimeter (Victor 3, Perkin Elmer, Norwalk, CT) with excitation and emission wavelengths of 365 and 450 nm, respectively. The ChT activity was expressed as nanomoles of substrate hydrolyzed per milliliter and hour (nmol/mL per hour). Samples were individually analyzed in triplicate and a valid result was considered when differences between them were less than 10%.

Complement system activity (TCA and ACA) was measured by hemolytic rate according to a novel technique described by Moreno-Indias et al. (2012a) in goat kid blood plasma. In this technique, a dextrose gelatin HEPES buffer [$DGHB^{++}$; HEPES Gelatin Veronal Buffer with Ca^{++} and Mg^{++}: 5 m*M* HEPES, 71 m*M* NaCl, 0.15 m*M* $CaCl_2$, 0.5 m*M* $MgCl_2$, 2.5% (wt/vol) glucose, 0.1% (wt/vol) gelatin, pH 7.4] is used to measure total complement system activity, and DGHB-Mg-EGTA buffer [4.2 m*M* HEPES, 59 m*M* NaCl, 7.0 m*M* $MgCl_2$, 2.08% (wt/vol) glucose, 0.08% (wt/vol) gelatin, 10 m*M* EGTA, pH 7.4] to measure the alternative pathway. For total complement system activity, rabbit red blood cells and lamb plasma diluted to 5% in $DGHB^{++}$ (100 μL of each) were mixed in a microtiter plate and incubated at 37°C for 1 h. Cells were removed by centrifugation (2,500 × *g*, 5 min, 4°C), and supernatant absorbance was measured at 405 nm (A_{405}) using a micro-plate reader. Complete hemolysis was achieved by mixing the cells with distilled water (100 μL), and spontaneous lysis was produced by mixing the diluted rabbit red blood cells with $DGHB^{++}$. Complement-induced hemolysis of rabbit red blood cells by the test sera was calculated using the formula: [(A_{405} sample − A_{405} spontaneous lysis)/(A_{405} complete hemolysis − A_{405} spontaneous lysis)] × 100. The same protocol was performed with DGHB-Mg-EGTA buffer to measure the alternative pathway.

Statistical Analyses

Statistical analyses were performed using SAS software (version 9.00, SAS Institute Inc., Cary, NC). The SAS PROC MIXED procedure for repeated measurements was used to evaluate the effect of colostrum source (goat vs. sheep) and TFCF (2 vs. 14 h after birth) on BW, IgG and IgM concentrations, ChT activity, and TCA and ACA of lambs from birth to 20 d after birth. A Tukey-Kramer test was used to evaluate differences between groups. No interactions between effects (colostrum source and TFCF) were observed.

RESULTS AND DISCUSSION

No differences in milk replacer intake were observed among groups during the experimental period. Additionally, consumption of milk replacer was constant between 2 and 5 d after birth (milk replacer intake expressed on a powder basis = 0.238 ± 0.08 kg/lamb

per day); however, this amount was increased in all groups at 20 d (0.405 ± 0.08 kg/lamb per day).

Results related to BW, IgG and IgM concentrations, ChT activity, TCA, and ACA during the first 5 d after birth and on d 20 are shown in Table 1. Lambs fed with goat or sheep colostrum at both TFCF lost BW during the first days of life, had not recovered to their birth BW by d 5, and gained >2 kg by d 20 of age. No BW differences were found between animals, either with different colostrum sources (goat vs. sheep) or with different TFCF (2 vs. 14 h). As observed by Rodríguez et al. (2008), lambs that are reared under restricted conditions (ad libitum intake twice daily) have a lower rate of BW gain (253 g/d) than animals raised with their dams (307 g/d). This fact could explain the observed BW evolution during the first 5 d after birth in the current study. In addition, Argüello et al. (2004) observed that goat kids reared under a natural rearing system were heavier than those reared under an artificial rearing system (twice ad libitum daily). In contrast to these findings, Napolitano et al. (2002) did not find differences in rate of BW gain between lambs reared under natural or artificial conditions (180 and 170 g/d, respectively). It is important to emphasize that neither colostrum source (goat vs. sheep) nor the delay in colostrum intake (2 vs.14 h after birth) had effects on lamb growth during the experimental period.

At birth (0 d), all animals had a detectable basal concentration of plasma IgG, probably of maternal origin through the placenta (Castro et al., 2011). These values increased sharply during the first 24 h after birth. The maximum IgG concentration was recorded at 24 to 48 h after birth and was not influenced by colostrum source or TFCF. No differences were observed between groups in this period, probably because all animals received the same amount of IgG relative to BW at birth. Several authors have noted that an increase in the total amount of IgG present in colostrum intake increases the IgG present in newborn ruminant blood, not only in lambs (Halliday and Williams, 1979) but also in calves (Muller and Ellinger, 1981; Stott and Fellah, 1983) and goat kids (Castro et al., 2005; Rodríguez et al., 2009). The results observed during the experimental period showed that no differences in plasma IgG concentration were due to colostrum source (goat vs. sheep) or TFCF (2 vs. 14 h).

Immunoglobulin M was not detectable in blood in any of the groups studied at birth (0 d). From d 1 to 2 after birth, the 4 groups showed an increase in IgM concentration; however, the concentration tended to gradually decrease in the following days. Differences due to colostrum source and TFCF were not observed. A similar evolution of plasma IgM concentration in goat kids was observed by Rodríguez et al. (2009) and Moreno-Indias et al. (2012a) during the first 5 d and the first 35 d after birth, respectively. Those authors described IgM concentrations similar to those in the present study, probably because their colostrum-fed animals showed the same amount of immunoglobulin G (4 g of IgG/kg of BW) during the colostrum period. Moreover, Rodríguez et al. (2009) noted that newborn goat kids fed a greater amount of IgM in colostrum had a greater IgM concentration in blood. Additionally, Stott and Fellah (1983) observed a quadratic relationship between the amount of IgM in colostrum and plasma IgM concentrations in calves. According to the results of our study, colostrum source (goat vs. sheep) and TFCF (2 h vs. 14 h after birth) did not affect IgM concentrations during the studied period.

Chitotriosidase activity was similar during the first 5 d after birth and increased in all groups by d 20 of age. No differences were observed among groups during the 20-d period. The evolution of this enzyme's activity has not been described previously in sheep. In goat kids fed colostrum at different IgG concentrations, Rodríguez et al. (2009) found no differences in blood ChT activity during the first 5 d after birth, although those authors described higher ChT activities than those observed in the present study (1,181, 1,183, 1,312, 1,278, 1,337, and 1,488 nmol/mL per hour at birth and at 1, 2, 3, 4, and 5 d after birth). As can happen with other proteins from breast milk, ChT may be inactivated or destroyed before reaching the intestine (Wold and Adlerberth, 2000). Consequently, this enzyme would not be absorbed by the intestine and would not affect ChT activity in blood. Following this line of argument, the primary role of ChT from colostrum is likely to protect the intestinal lumen of the newborn, increasing the activity of the enzyme in blood only when the animal becomes older by progressive activation of macrophages (Argüello et al., 2008). As ChT activity was observed at birth, it is possible that this enzyme is transferred from the dam to the fetus during pregnancy, although no reference to support this statement has been found in the literature. Finally, the increase in ChT activity observed in all groups at d 20 of life may be explained by the progressive development of the immune system. As suggested by Argüello et al. (2008), macrophages are gradually activated with age, and therefore the secretion of ChT by macrophages also increases. Although ChT activity of lambs at 20 d of life has not been previously reported, values in the present study are lower than those observed by Argüello et al. (2008) in goat kids at 21 d of age. Our results suggest that neither colostrum source (goat vs. sheep) nor TFCF (2 h vs.14 h after birth) affected blood ChT activity in newborn lambs.

Complement system activity (TCA and ACA) was not detectable at birth (0 d) in any of the studied

Table 1. Body weight, IgG and IgM concentrations, chitotriosidase activity (ChT), and complement system activity (TCA and ACA) of lambs fed with 2 colostrum sources (goat vs. sheep) and timing of first colostrum intake (TFCF, 2 vs. 14 h) for 20 d after birth

Item[1]	Days after birth	Colostrum source		TFCF		Effect[2]					
		Goat	Sheep	2 h	14 h	Col	T	D	Col × T	Col × D	T × D
BW (kg)	0	4.22 ± 0.84[a]	4.52 ± 0.58[a]	4.33 ± 0.70[a]	4.40 ± 0.68[a]	NS	NS	<0.0001	NS	NS	NS
	1	4.06 ± 0.80[b]	4.29 ± 0.54[b]	4.13 ± 0.62[b]	4.22 ± 0.72[b]						
	2	3.95 ± 0.83[c]	4.22 ± 0.60[b]	4.05 ± 0.61[b]	4.12 ± 0.80[b]						
	3	3.99 ± 0.85[b]	4.22 ± 0.61[b]	4.11 ± 0.66[b]	4.09 ± 0.78[b]						
	4	4.07 ± 0.85[b]	4.22 ± 0.59[b]	4.18 ± 0.67[b]	4.11 ± 0.77[b]						
	5	4.19 ± 0.88[a]	4.30 ± 0.61[b]	4.28 ± 0.67[a]	4.21 ± 0.82[b]						
	20	6.79 ± 0.91[d]	6.77 ± 0.85[d]	6.89 ± 0.96[c]	6.58 ± 0.89[c]						
IgG (mg/mL)	0	0.19 ± 0.09[a]	0.21 ± 0.12[a]	0.23 ± 0.15[a]	0.18 ± 0.10[a]	NS	NS	<0.0001	NS	NS	0.014
	1	7.91 ± 2.15[b]	7.04 ± 2.23[b]	8.50 ± 0.79[b]	6.45 ± 0.95[b]						
	2	9.04 ± 2.45[c]	8.76 ± 2.12[b]	10.18 ± 2.8[b]	8.62 ± 1.12[c]						
	3	6.45 ± 2.68[d]	6.04 ± 1.78[bc]	8.26 ± 1.03[bc]	7.23 ± 1.99[b]						
	4	6.22 ± 1.72[d]	6.38 ± 1.9[bc]	7.85 ± 1.19[c]	6.75 ± 1.62[b]						
	5	5.35 ± 2.60[d]	5.33 ± 2.98[c]	7.43 ± 1.11[c]	6.25 ± 1.01[b]						
	20	5.68 ± 2.32[d]	5.23 ± 2.42[c]	7.83 ± 1.23[d]	7.21 ± 1.35[c]						
IgM (mg/mL)	0	ND[3]	ND	ND	ND	NS	NS	<0.0001	NS	NS	0.008
	1	0.38 ± 0.24[a]	0.79 ± 0.37[ab]	0.79 ± 0.22[a]	0.39 ± 0.27[a]						
	2	0.75 ± 0.09[b]	0.91 ± 0.09[a]	0.69 ± 0.24[ab]	0.77 ± 0.21[b]						
	3	0.56 ± 0.23[ab]	0.64 ± 0.25[b]	0.64 ± 0.21[ab]	0.56 ± 0.20[ab]						
	4	0.57 ± 0.23[ab]	0.44 ± 0.25[b]	0.53 ± 0.26[b]	0.48 ± 0.18[a]						
	5	0.42 ± 0.16[a]	0.40 ± 0.15[b]	0.47 ± 0.14[b]	0.35 ± 0.12[a]						
	20	0.46 ± 0.23[a]	0.43 ± 0.20[b]	0.47 ± 0.22[b]	0.41 ± 0.21[a]						
ChT (nmol/mL per hour)	0	846 ± 425[a]	738 ± 335[a]	870 ± 243[a]	714 ± 321[a]	NS	NS	0.013	NS	NS	NS
	1	890 ± 448[a]	777 ± 353[a]	916 ± 256[a]	751 ± 405[a]						
	2	784 ± 341[a]	711 ± 280[a]	798 ± 195[a]	797 ± 352[a]						
	3	756 ± 370[a]	722 ± 317[a]	790 ± 246[a]	789 ± 282[a]						
	4	798 ± 236[a]	752 ± 322[a]	760 ± 268[a]	789 ± 374[a]						
	5	905 ± 365[a]	941 ± 185[ab]	978 ± 311[a]	969 ± 296[a]						
	20	1,339 ± 308[b]	1,359 ± 289[b]	1,393 ± 440[b]	1,341 ± 361[b]						
TCA (%)	0	ND	ND	ND	ND	0.011	NS	<0.0001	NS	NS	NS
	1	1.35 ± 0.90[a]	1.95 ± 1.10[a]	1.79 ± 1.22[a]	1.51 ± 1.26[a]						
	2	4.21 ± 1.35[ab]	10.06 ± 1.23[b]	4.50 ± 2.90[a]	9.77 ± 2.72[b]						
	3	6.72 ± 2.68[b,z]	16.99 ± 2.41[c,y]	10.30 ± 3.10[b]	13.40 ± 3.21[bc]						
	4	11.05 ± 3.65[c,z]	21.66 ± 3.21[cd,y]	14.52 ± 2.85[bc]	18.18 ± 2.75[c]						
	5	12.56 ± 3.21[c,z]	22.60 ± 4.11[d,y]	18.80 ± 3.20[c]	16.36 ± 2.85[c]						
	20	35.69 ± 5.21[d]	36.70 6.23[d]	34.83 ± 4.65[d]	37.56 ± 4.35[d]						
ACA (%)	0	ND	ND	ND	ND	NS	NS	<0.0001	NS	NS	NS
	1	0.51 ± 0.45[a]	1.06 ± 0.59[a]	0.41 ± 0.35[a]	1.16 ± 0.63[a]						
	2	3.71 ± 2.68[a]	7.69 ± 3.25[b]	3.33 ± 2.75[a]	8.07 ± 2.23[b]						
	3	4.86 ± 2.36[a]	10.90 ± 3.65[bc]	4.63 ± 3.25[a]	11.14 ± 4.21[bc]						
	4	11.00 ± 3.58[b]	12.00 ± 3.89[bc]	11.16 ± 3.21[b]	11.85 ± 2.93[c]						
	5	10.11 ± 2.09[b]	15.95 ± 4.23[c]	13.30 ± 2.54[b]	12.76 ± 3.69[c]						
	20	29.66 ± 5.10[c]	28.56 ± 5.36[d]	27.50 ± 3.65[c]	30.12 ± 3.87[d]						

[a–d]Means within a column for a specific item with different superscript letters differ significantly ($P < 0.05$).

[z,y]Means within a row with different superscript letters differ significantly ($P < 0.05$).

[1]TCA = total complement system activity; ACA = alternative complement system activity.

[2]Col = colostrum source; T = timing of first colostrum intake; D = days after birth.

[3]ND = nondetectable.

groups, becoming detectable from d 1 after birth and reaching a maximum value at the end of this study (20 d). In general, no differences in complement system activity were found between study groups, although we found that lambs fed sheep colostrum showed a higher TCA at d 3, 4, and 5 compared with lambs fed goat colostrum. Despite these findings, no differences were observed between groups at d 20. As no differences in ACA were found, we can assume that the increase of the TCA was produced by activation of the classical complement system activity pathway. In accordance with these findings, Eckblad et al. (1981) suggested that complement system components in colostrum might play an essential role in the development of complement system activity in newborn animals through gut absorption. Our findings suggest that lambs fed sheep colostrum could have earlier activation of the classical complement system pathway compared with those fed with goat colostrum. According to Tabel (1996), the ACA pathway does not require antibody for activation, whereas activation of the classical pathway is antibody mediated. In our study, the greater phylogenetic affinity of sheep immunoglobulins present in the sheep colostrum compared with goat immunoglobulins present in goat colostrum could produce higher activation of the classical pathway in lambs. Results of the current study indicate that TFCF (2 h vs. 14 h after birth) did not affect the complement system development, although colostrum source (goat vs. sheep) may partly affect it.

CONCLUSIONS

In general, lamb immune variables (IgG and IgM concentrations, ChT activity, and complement system activity) and BW were not affected by either colostrum source (goat vs. sheep) or TFCF (2 vs. 14 h) during the first 5 d after birth and at d 20 of age. Further studies with other colostrum amounts (8 and 16 g of IgG/kg of BW) are necessary to determine whether higher plasma immune variables and greater BW in lambs could be obtained during these first days after birth. These findings may improve management systems in lamb farms. Based on our results, it is not necessary to feed colostrum immediately after birth and goat colostrum can be used to bottle-feed newborn lambs without consequences for their immune system and BW.

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