Colostrum-period management: impact on goat kids' body weight and immune system

The effect of colostrum-period management on the mmune system of small ruminant neonates, from birth to slaughter, is outlined by Anastasio Argüello DVM PhD and Noemí Castro DVM PhD, members of the Animal Production and Biotechnology Group, Institute of Animal Health and Food Safety, Universidad de Las Palmas de Gran Canaria, Spain

Colostrum is a nutrient-rich fluid produced by female mammals immediately after giving birth. Due to its high content in immunoglobulins (Ig), mainly immunoglobulin G (IgG), colostrum provides the major antimicrobial protection and confers passive immunity preventing diseases caused by microbial infections in the newborn (Foley and Otterby, 1978). In ruminants, the structure of the placenta impedes the transfer of Ig from the dam to the foetus, which makes colostrum the only source of Ig in the first week of life.
It is generally recommended that newborns be fed with fresh, high-quality colostrum as soon as possible after birth. However, one potential method of transmission of infectious diseases to dairy animals is through feeding infective colostrum. Pathogens that may be transmitted within colostrum, either by direct sucking of the mammary gland or post-harvest contamination, include bacteria such as *Mycobacterium avium* subp *paratuberculosis*, *Salmonella* spp, *Listeria monocytogenes*, and *Escherichia coli* (Steele et al, 1997), or viruses such as caprine arthritis-encephalitis (Guerrault, 1990) and bovine leukosis (Perrin and Polack, 1988).

IMMUNOGLOBULINS AND APOPTOSIS

The absorption of Ig by neonate enterocytes is not well known. The Fc receptor plays an important role, fixing the Fc region of the Ig and interiorising it. What is new knowledge is the relation of this process with enterocyte apoptosis. Castro-Alonso et al (2008) observed this relationship. In Figure 1, on day one of age, IgG was internalised and transported by enterocytes (arrow in IgG-d 1), and accumulated in the vascular villi system (Jochims et al, 1994). TUNEL staining for apoptosis was significantly reduced at this age. Thus, IgG absorption was related to apoptotic changes in enterocytes. Serum blood IgG did not record in the present experiment, but previous experiments (Castro el at, 2005, Castro et al, 2007) had demonstrated that the main period for IgG absorption on kid goats was the first 24 hours of life. On day two of age, the cytoplasm and vascular villi of some

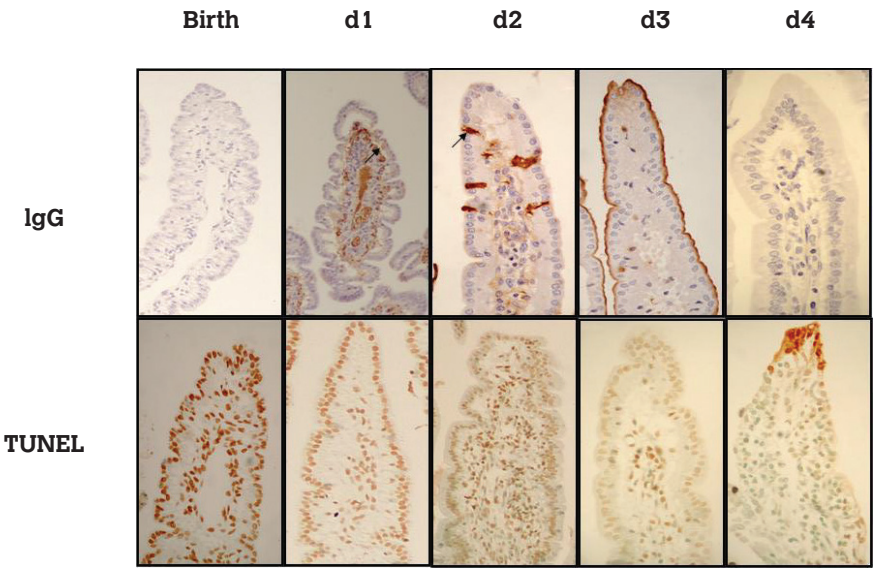

Figure 1: TUNEL and IgG staining in duodenum of goat kids slaughtered at birth or at one, two, three or 60 days of age.
Source: Castro-Alonso A et al. J Dairy Sci 2008; 91: 2086-2088.

enterocytes displayed marked IgG immunostaining (see Figure 1; arrow in IgG-d 2). In contrast, TUNEL staining was markedly reduced after day two of age. Thus, IgG was found bound to enterocytes but was not internalised (Figure 1; IgG-d 3). TUNEL staining for apoptosis was modest at this time point (see Figure 1; TUNEL-d 3). IgG immunostaining was not observed in kids slaughtered at 60 days of age and apoptosis was limited to a few cells at the apex of the intestinal villi (Figure 1; TUNEL-d 60).

DAM VERSUS BOTTLE

Multiple methods have been proposed to manage the feeding colostrum period in small ruminants, but none can replace the natural suckling. Assuming that, and taking in consideration the labour cost, the restricted method proposed for Argüello et al (2004) has been used successfully (see Figure 2). According to the proposed method, the 10% of the birth weight must be fed in two days. In a practical way, if the birth weight of a goat kid or a lamb is 4kg, the 10% represent 400ml to be fed in two days (200ml per day).

COLOSTRUM AND MORTALITY

The relationship between colostrum and mortality is well known, but it is not direct. As colostrum is the only source of Ig in small ruminant neonates, animals receiving low amount of colostrum or bad quality colostrum increase the risk of

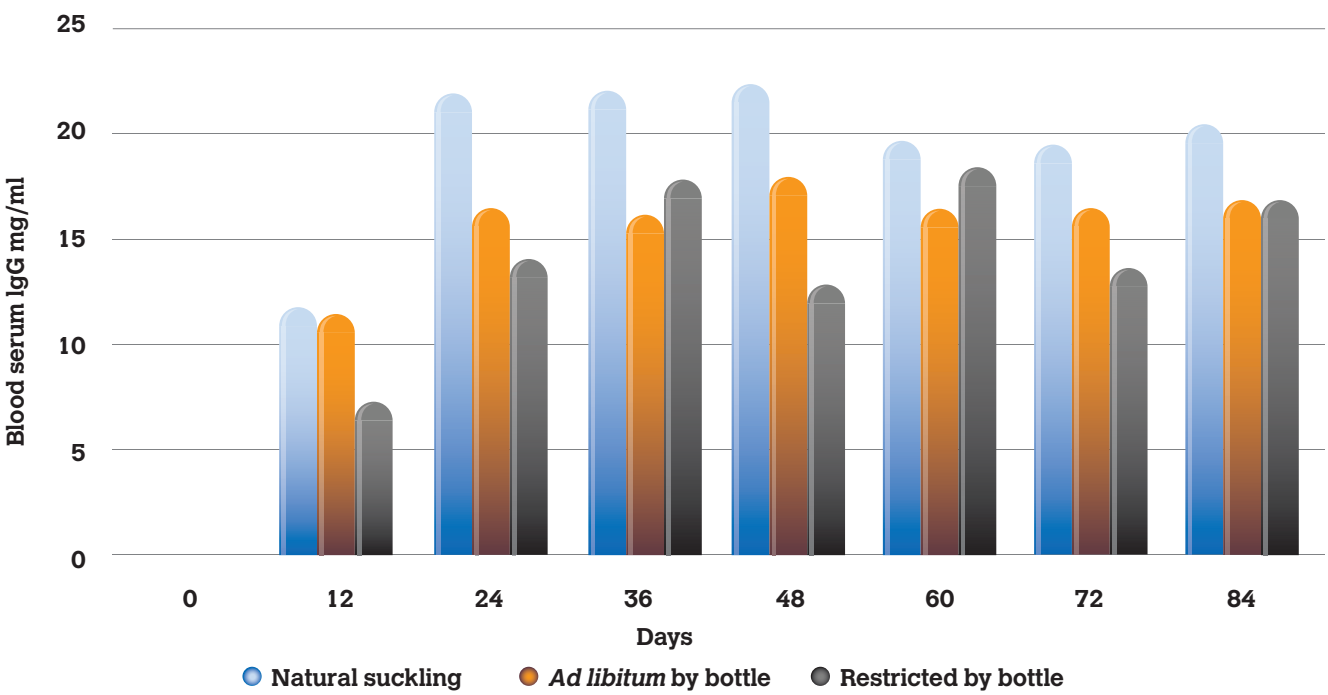

Figure 2: Effect of different colostrum management practices on blood serum IgG.

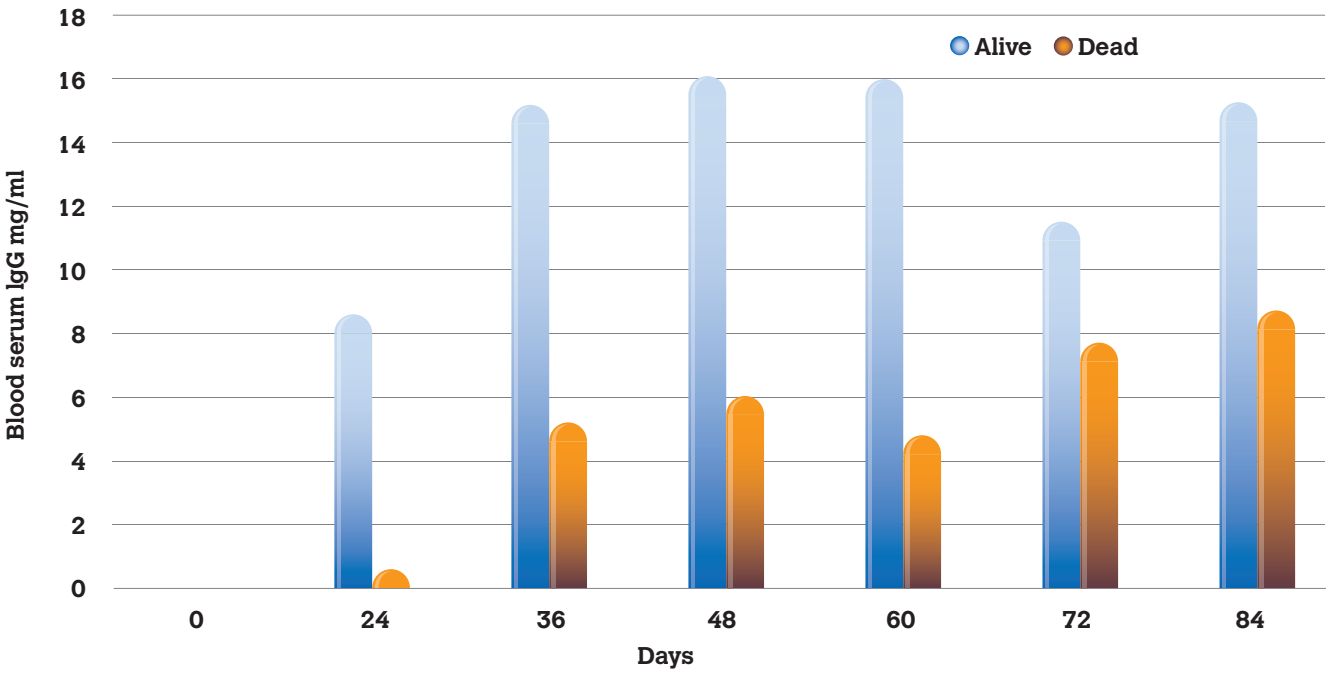

Figure 3: IgG blood concentration in reference to mortality.

diseases. Argüello et al (2004) observed a lower IgG blood serum concentration in dead goat kids compared to alive ones (see Figure 3).

COLOSTRUM HYGIENISATION

As it has been stated previously, colostrum can be a carrier for multiple pathogens. To control these diseases (Johne's disease, caprine arthritis-encephalitis virus [CAEV], etc.) the use of hygienisation methods is necessary. Traditionally, the pasteurisation method has been widely used. Arguello et al (2003) used two methods, the first of these consisted of pasteurisation at 56°C for 60 minutes while in the second case the sample was pasteurised at 57°C for 10 minutes and then transferred directly to a thermos bottle which had been preheated with boiling water, where it remained for a one-hour period. Pasteurisation of colostrum, has a negative effect on IgG concentration, reducing it in the first case by 36.92% and by 37.84% in the second. The colony forming units were strongly reduced by both pasteurisation processes. Major significant differences between the IgG concentration

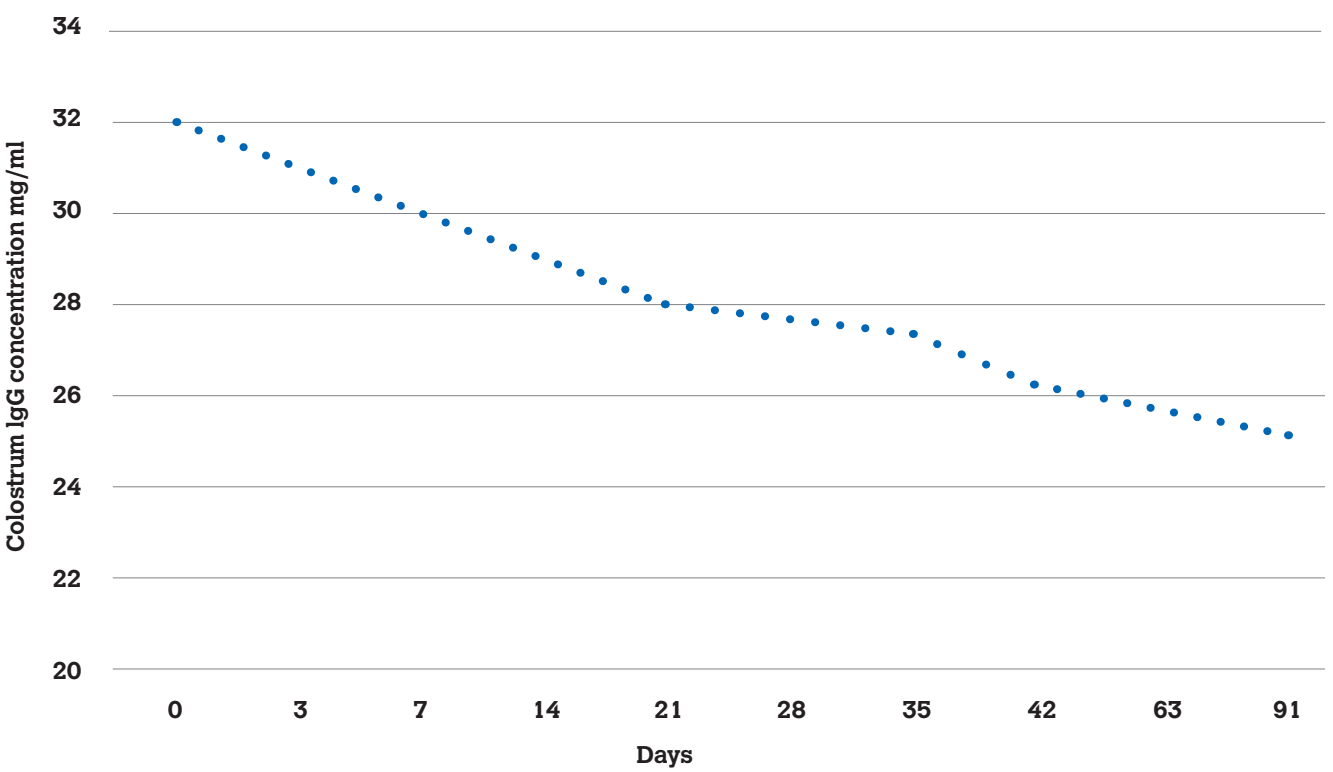

Figure 4: Evolution of colostrum IgG concentration at 4°C during 91 days.

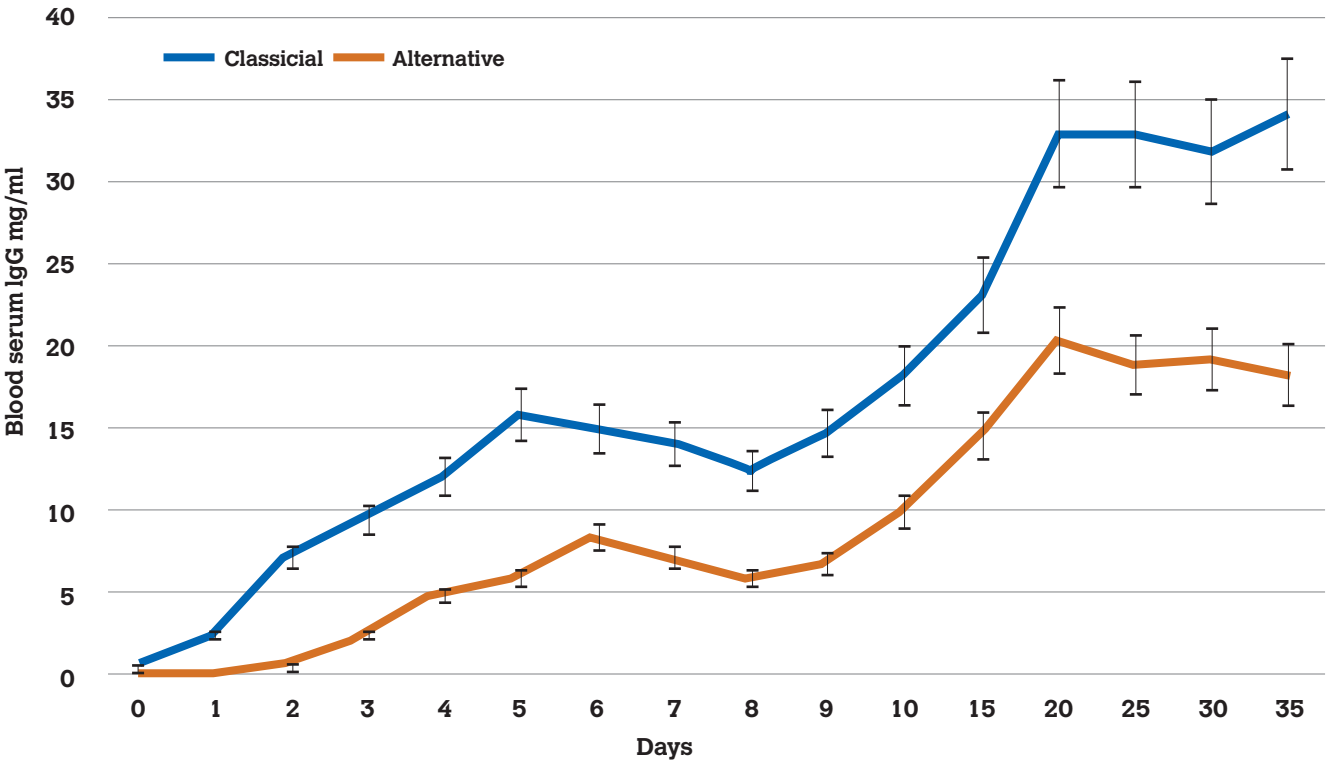

Figure 5: Evolution of complement activity (classical and alternative pathway) in goat kids from birth to 35 days of life.

in colostrum prior to and after pasteurisation treatments were observed, while no statistically significant differences were observed between the two treatments carried out.

According to Trujillo et al (2007), traditional heat treatments of 56°C for 60 minutes and 63°C for 30 minutes could help to obtain hygienic goat colostrum of good microbiological quality while mostly preserving the IgG concentration. Furthermore, high-pressure treatments at 400 and 500MPa produced satisfactory sanitation of goat colostrum to a similar extent as heat treatments, but treatment of 500MPa caused significant losses of IgG in goat colostrum. Although the results reported by this group are promising, they suggest the possibility of hygienising goat colostrum by heat or pressure (400MPa) treatments while maintaining Ig content, the findings are preliminary and should be interpreted with caution. More experiments must be performed in order to study this new technology in particular pathogens, and economic viability must be addressed.

New hygienisation methods have been proposed. Morales-delaNuez et al (2011 and erratum) showed the first data concerning the use of sodium dodecyl sulphate (SDS) as a sanitation agent in animal colostrum, although some information on the use of SDS to treat human colostrum is available. Hartmann et al (2006) found that the addition of SDS to human milk did not significantly decrease the IgA concentration. In human milk treated with 1% SDS, the IgA concentration was 24.66mg/dcl before and 22.66mg/dcl after SDS treatment. Human colostrum is richer in IgA than IgG, but the absence of a reduction in IgA in human colostrum following SDS treatment was similar to that observed for IgG in the Morales-delaNuez et al (2001) study. Bacterial contamination, in goat colostrum, was strongly reduced by the pasteurisation process (used as a control) and 0.1% SDS treatment.

The SDS treatment consisted of preparing a stock solution of 10% (100mg/ml) of SDS in sterile deionised water and keeping at room temperature. Colostrum was mixed with stock solution resulting in a final SDS 0.1%. After that, colostrum was incubated with SDS for 10 minutes at 37°C in a water bath. Hartmann et al (2006) concluded that HIV-1 can be inactivated in human milk with inexpensive microbicides, while conserving important human milk constituents. We hypothesise that, similar to its effects on HIV-1, SDS treatment may also inactivate the CAEV, although this hypothesis requires further investigation.

COLOSTRUM CONSERVATION

In reference to colostrum refrigeration, Figure 4 shows the evolution of IgG concentration in goat colostrum kept in refrigeration at 4°C over a 91-day-period. No significant statistical variation was observed in this concentration during refrigeration time, although it did tend to diminish at the end of the experiment (24%). The main reduction occurred during the first month of the test (17%), possibly because it was during this period that the natural fermentation of the colostrum took place (Argüello et al, 2003).

The freezing of colostrum is a well-known method of preservation. Morand-Fehr (1989) stated that IG present in goat colostrum remain intact for two years, while Bilbao et al (2001) ascertained that the maximum freezing time for bovine colostrum is 15 years. Argüello et al (2003) has showed the evolution of IgG concentrations in colostrum throughout the freezing-thawing cycles with different thawing methods (thawing in hot water, refrigeration, room temperature and microwave). There is no statistical

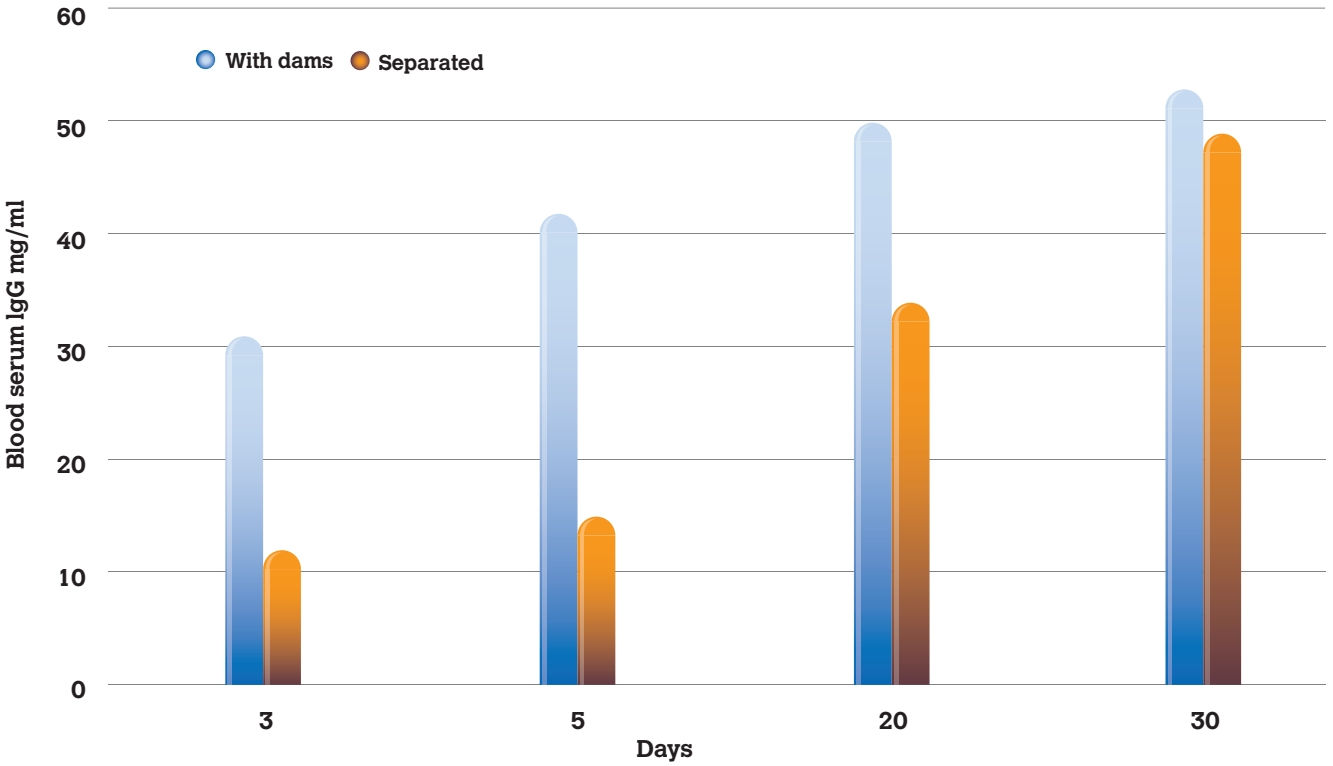

Figure 6: Complement system activity (classical pathway) in lambs with their dams and separate, from birth to 30 days of life.

interaction between the two effects (cycle and thawing method), since the thawing method used shows no variation with respect to IgG concentration, although the number of times the colostrum was subsequently refrozen and thawed does have a reducing effect on IgG concentration. In that experiment, the levels of reduction after seven cycles were 27%, 33%, 34%, and 30% (thawing in hot water, refrigeration, room temperature and microwave, respectively). The thawing method used has been shown to have no statistical effect on IgG levels, which leaves each farm free to choose the thawing method which most suits it. The reduction of IgG levels after several freezing-thawing cycles is probably due to the effect of temperature changes, though on no occasion did the temperature exceed 60°C, the temperature at which globulins begin to break up, as has been demonstrated by Anema (2000).

NEONATES AND THE COMPLEMENT SYSTEM

It is well known that the complement system is an important part of the innate immunity; what is not really clear is that the complement system is not fully developed until the first month of life. Figure 5 shows haemolysis percentages of the classical and alternative pathways of the complement system in goat kids during the first 35 days of life.

In Figure 6, provide by Hernandez-Castellano et al (2015), complement system activity (total activity) increased until the end of the milk feeding period in lambs. Complement system activity is affected by neonate management and feeding. Lambs raised with their dams displayed a higher complement activity than separated lambs. At the end of the milk-feeding period, no differences are shown. Oswald et al (1990) wrote that the great increase of the complement system activity after birth may be explained by the passive transfer of complement factors from colostrum. As the lambs with their dams received an unrestricted amount of colostrum and milk, lambs from this group could absorb a higher amount of complement factors than separated lambs, as it has been observed in newborn goat kids (Castro et al, 2008).

THE FUTURE

Colostrum is not only a source of Ig. New techniques are helping us to understand the role of colostrum in the immunity of the neonate. Hernandez-Castellano et al (2014) has demonstrated that not only IgG is increased in the blood serum of the small ruminant neonates.

Colostrum intake produced an increase of non-immunoglobulin proteins in lamb-blood plasma, such as apoliprotein A-IV, plasminogen, serum amyloid A and fibrinogen. These proteins have reported immune functions in other species, suggesting that colostrum provides not only IgG, but also non-immunoglobulin proteins. These proteins could play a fundamental role in the activation and attraction of immune cells, the apoptosis rate of the enterocytes and the low gastric secretion, among other roles. The results of this work contribute information about proteins with immune function that are increased after colostrum intake. High-plasma concentrations of these proteins may decrease lamb mortality and increase the economic benefit for farmers.

In the future, further proteomic studies will be necessary in order to increase general knowledge about the role of colostrum in passive immune transfer.

REFERENCES ON REQUEST