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Colostrum as the speed up key for ruminant newborn: what do we know and should further characterize

Abstract

Feeding and management programs are essential to determine neonatal health and survival. Therefore, an adequate and early intake of high quality colostrum, rich in antibodies and nutrients, is crucial. Some factors such as i) season; ii) length of the dry period and nutrition; iii) number of births; iv) litter size; v) body condition; vi) milk production; vii) fat and protein content; viii) somatic cell count and ix) breed/geneticshave been associated with the quality of colostrum. Colostral nutritional and protective characteristicsmay be assessed through the protein concentration, which reflects the amount of albumin and globulins, indicating the success or failure in passive transference of immunity. Failure to passive immunoglobulin transfer results in an increased risk of morbidity and mortality of the newborn. This review addresses factors with potential to interfere with the quality of colostrum, prospecting future research in sheep.

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Introduction

In extensive sheep production systems current neonatal mortality can reach 15-20%, with a possible increase in case of multiparous deliveries. The amount of colostrum available at birth, to which mother's nutrition stands as a relevant factor, plays a major role in neonate survival.[1] Failure in passive transference of immunity increases the risk of newborn mortality, turning essential to provide an adequate amount of high-quality colostrum, early in the first hours of life, in order to establish thatlife-saving passive immunity.[2,3]

Several factors have been described with potential to interfere with the quality of colostrum, such as the i) season; ii) length of the dry period and nutrition;iii) number of births;iv) litter size;v) body condition; vi) milk production; vii) fat and protein content; viii) somatic cell count and ix) breed/genetics.[4–6] Further identification and characterization of parameters with possible implication in the quality of ovine colostrum, such as the season, the environmental temperature, the number of births is becoming more and more perceived. In addition, the length of the dry period, as well as the age at first delivery, should also be considered.

The frame for the colostrum quality

Colostrum characterization: Colostrum is the first liquid that provides food to the newborn. It is rich in proteins, vitamins, minerals, lactoferrin, lysozyme, antimicrobial peptides and growth factors, which are nutritionally important, but composition also evolves during the first days after delivery as it is shown in Table 1, regarding bovine.[7,8] Colostrum is definitely different from milk, mainly because it contains a high level of antibodies against a diversity of potentially infectious agents playing a vital role in immunity and thus contributing to the development of the gastrointestinal tract, conditioning the endocrine system and metabolism, and providing an essential source of energy for young animals to generate heat, preventing hypothermia.[9,10] While normal sheep's milk contains 12% solids, the same parameter in colostrum has a rate of 22%. This difference is mainly associated to the concentration of immunoglobulins, but furthermore the solid matter is richer in casein, fat, protein and vitamins A, B12, D, and E, although lower in lactose.[11,12] Approximately 92% of the total immunoglobulins belong to the IgG class, 6% to IgA and 2% to IgM.[13]

Table 1 Composition of colostrum[8]

	Peripartum	24h	72h	Milk
Solids (%)	23.9	17.9	14.1	12.9
Proteins (%)	14.0	8.4	5.1	3.1
Fat (%)	6.7	5.4	3.9	3.7
Lactose (%)	2.7	3.9	4.4	5.0
Minerals (%)	1.1	0.95	0.87	0.74
Immunoglobulins (%)	6.0	4.2	2.4	0.09

Passive transference of immunity

Passive transference of immunity is defined as the transfer of immunoglobulins from the mother to the newborn, through colostrum.[14] Colostrum must be of high quality, with an IgG concentration ≥15 mg/mL.[15,16] Content in immunoglobulinsmay be roughly perceivedfrom total protein concentration in serum, which reflects the amount of albumin and globulins, but this technique lacks enough specificity.[17] Confirmatory tests considered as the golden standard for IgG measurement include single radial immunodiffusion and ELISA.[18] As passive immunity is essential for the newborn ruminant and failure in passive transfer increases the risk of morbidity and mortality, studying the factors that affect the quality of colostrum is an essential issue. According to Bartier et al.,[15] and Tyler et al.,[21] an incorrect management can lead to the death of the newborn and 39 to 50% of mortality may be associated to the failure of passive transfer of colostrum antibodies.[20,21]

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Parameters associated with colostrum quality

In ruminants, colostrum is the only way to acquire immunity soon after birth because of the epithelial placenta, which prevents *in uterus* diffusion of immunoglobulins.[2,22] Therefore, colostrum should be provided as early as possible after birth to ensure the appropriate passive transfer of antibodies from the mother to the neonate.[18] It should make up to 10% of the birth weight in the first 24 hours postpartum.[23] Its supply must occur early, within this period, as the intestinal process of passive immunoglobulin absorption ceases ("intestinal closure") approximately 24 hours after birth. Therefore, any delay in breastfeeding the newborn or low quality/amount of colostrum will reduce the level of immunoglobulins absorbed, increasing the susceptibility to pathogens, with a higher morbidity/mortality.[22] A colostrum that has a minimum IgG concentration of 50 g/L, a total bacterial count <100,000 cfu/mL and a total coliform count <10.000 cfu/mL can be considered of good quality.[24–28] The concentration of immunoglobulinsmay vary between breed, number of lactations, duration of dry periods, volume of colostrum, milking in the prepartum period and number/frequency of milking after delivery.[29–31] Therefore, the success of the immune transfer depends on factors related to the sheep, the lamb and to the handling of these animals.[16]

a. Body condition

The body condition is based on a scoring system designed to evaluate the corporal reserves of animals and consists on the evaluation of several parameters of animalexternal appearance. It is associated with the energy balance, which correlateswith body fat, milk production and reproduction, and should contribute to the maximum production with the best health status.[32]

To maintain the desirable balance of body condition,meeting sheep's nutritional needs, in order to guarantee a good quantity and quality of colostrum for the newborn is crucial.[1] At the end of pregnancy, nutrition strongly influences gland development and mammary cell differentiation, demanding a good nutritional management that promotes proper udder development with enough production of colostrum for the neonates.[12,33–36] Preferably, optimum productivity is obtained in sheep presentinga medium body condition (*e.g.*3) requiring an evaluation one month before the mating begins.[37]

b. Season

First hours after birth are critical for newborn survival as it must neutralize the enormous heat loss in result of the environmental transition from the warm uterus to the outside. During the first 15 minutes after birth the internal temperature of a lamb decreases between 1 and 2 °C, regarding the 39 °C of the intrauterine environment. The colder the external environment is, the faster lamb's metabolism must be, to maintain the homeothermic status. Other environmental conditions must also be considered, likewind speed and humidity, which will influence the rate of heat loss associated to the evaporation of amniotic fluids. Nardone et al.,[22] reported heat stress related to high environmental temperature in association withan impaired transference of IgG from plasma to the udder, resulting in lower colostrum concentration of IgG as well as IgA, but not IgM or lactoglobulin.[38] Therefore, good environmental management is crucial to allow the consumption of sufficient amount of good quality colostrum which in turn will meet the high energy thermoregulation requirementsof small newborn ruminants.[5]

c. Duration of the dry period

The dry period is very important in a dairy farm because it allows the udder to rest between two successive lactations.[39] The length of the dry period can influence the concentration of immunoglobulins, since its secretion in the mammary gland starts between four to six weeks before delivery (Silva, 2019).[15] In cattle, the maximum production of antibodies is reached with dry periods of at least 40 days.[40]

d. Number of deliveries

The colostrum of first calving is less rich in immunoglobulins when compared to that of subsequent pregnancies and that happens because immunization against pathogens, to which animals become exposed to, with the production of specific antibodies (which will be transferred to the colostrum) is a lifelong process.[41,42] Muller and Ellinger (1981) demonstrated that third lactation cows present a higher concentration of IgG in colostrum than those from first or second lactation, with a progressive increase in colostrum IgG until the third or fourth calves.[43] In addition to the number of births, reported the existence of a significant difference between lambs from simple and twin births. Twin lambs showed passive transfer failure as they born smaller, weaker and did not suck colostrum properly and in sufficient amounts.[17]

e. Milk production

The available information on the influence of good quality colostrum on ruminant productivity is somehow limited, however, Godden et al. (2009) described the failure inpassive transference ofimmunity in heifers as associated with reduced milk and fat production at first lactation and delayed age at first calving.[44] It is also expected that those animals will show a colostrum deficit, considering the existence of a positive correlation between body weight and the concentration of immunoglobulins in colostrum.[45] Thus, in terms of productive management, the drying phase and nutrition during this period should be decisive for the quality of colostrum.

f. Genetics

Regarding the relevance of genetic factors to the quality of colostrum it is known that the concentration of IgG and nutritional factors in colostrum shows considerable variation in sheep, with special association to breed.[5]Hence, a characterization of the qualitative variation of colostrum must consider the different management factors, like nutritional, environmental and reproductive, relating them with breed and aptitude.This will make possible the identification of associations between parameters, allowing formulating adjustments for productive improvement.The Merino/Suffolk comparative approach could stand as a good studying model.

Discussion

Some studies have associated the quality of colostrum with the calving season, with results showing that, in the case of cattle, animals that calved in winter presented a higher concentration of immunoglobulins and, in spring, a higher concentration of fat in the colostrum.[46] Volume is another parameter associated with the season,but not much scientific information is available.[4] Recent studies in cattle have pointed to a higher concentration of immunoglobulins in colostrum, in association with energy-restricted diet during the dry period, when compared with more energetic diets, where a higher percentage of fat was associated with the supply of

concentrate between 0 and 3 weeks pre-delivery.[46] On the other hand, the quality of colostrum and the absorption of IgG by the newborn show a decrease in summer as a result of heat stress.[47] Furthermore, very relevant parameters for colostrum quality as concentration in IgG and nutritional factors have shown marked variation between different sheep breeds.[5] Hence, aiming a better neonatal health and performance, studying colostrum quality should focus on the above parameters, regarding their influence on a specific breed.

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Conflicts of interest

Author declares that there are no conflicts of interest.

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