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From goat colostrum to milk: Physical, chemical, and immune evolution from partum to 90 days postpartum

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ABSTRACT

This study focused on the study of the changes originated in the milk from partum until d 90 of lactation. Ten multiparous Majorera goats, bred carefully under animal health standards, with a litter size of 2 kids (the average in this breed is 1.83 prolificacy) and similar gestation length (149 ± 1 d) were used. Goat kids were removed from their dams to avoid interferences with the study. Compositional content (fat, protein, and lactose) were measured, as well as some other properties, including pH, density, titratable acidity, ethanol stability, rennet clotting time, and somatic cell count. Moreover, immunity molecules (IgG, IgA, and IgM concentrations and chitotriosidase activity) received great attention. Fat and protein content were higher in the first days postpartum, whereas lactose content was lower. Density, titratable acidity, rennet clotting time, and somatic cell count decreased throughout the lactation period, whereas pH and ethanol stability increased. Relative to the immunological parameters, each measured parameter obtained its maximum level at d 0, showing the first milking as the choice to provide immunity to the newborn kids. On the other hand, this study might be used to establish what the best use is: processing or kid feeding.
Key words: goat colostrum, milk composition, immunological parameter, technological property

INTRODUCTION

Colostrum is the initial milk secreted by mammals during parturition and the first few days after birth. It provides protection to the immune system of newborns and provides passive immunity against pathogens. The transition period is marked by nutritional, metabolic, hormonal, and immunological changes that have an effect on the incidence of infections and metabolic diseases. During the transition from colostrum to normal milk, gradual or sometimes sudden changes may occur in composition and properties (Arain et al., 2008). Tsioulpas et al. (2007) reported changes in physical and technological parameters from colostrum to milk in cows, and Argüello et al. (2006) observed that caprine colostrum exhibits some extreme physical properties. Abd El-Fattah et al. (2012) reported in buffalo and cows that the compositions of both colostrums approach those of normal milk within 5 d after parturition. Some studies have focused on the composition of goat milk through the lactation curve (Delgado-Pertíñez et al., 2009); Argüello et al. (2006) described how the number of lactations and litter size affect the immune and physical goat colostrum characteristics until 5 d postpartum. But to our knowledge, no studies about immune characteristics are available as far as 5 d postpartum of dairy goats.

Complete knowledge of the changes occurring in the lactation period is critical for the establishment of milk quality criteria, as part of the payment system for milk, which will ensure better quality of the final dairy products (Raynal-Ljutovac et al., 2005). Those authors reported some observations, such as the legislation-restricted IgG content in milk because of the negative effects of colostrum on cow milk (e.g., less-effective pasteurization, decreased heat stability of milk, and lower cheese yield and curd firmness). These effects were linked to the increase in total soluble protein content, and greatly depend on the colostrum addition. Indeed, Suchanek et al. (1978), when adding 10% of colostrum from d 4 to 7 postpartum in cow milk, did not observe significant modification of parameters such as acidification ability, rennet coagulation, heat stability at 135°C, and cheese-making parameters of Edam-type cheese. Zawistowski and Mackinnon (1993) reported that the presence of high levels of bovine IgG could adversely affect the human immune system. Argüello (2011) presented the most up-to-date trends in goat research, remarking that it needs to progress rapidly to reach the level of knowledge of other species such as cattle and sheep. Due to lack of information in goats, the aim

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of the present study was to evaluate the evolution of physical, chemical, and immune parameters in the goat transition period from colostrum to milk during the first 90 d postpartum.

MATERIALS AND METHODS

Animals and Samples Collection

Experimental animal procedures were approved by the Ethics Committee of the Universidad de Las Palmas de Gran Canaria (ULPGC, Arucas, Spain). Goat colostrum and milk samples were collected from the ULPGC farm at partum and each day postpartum at 0800 h from 10 Majorera dairy goats; the samples were transported to the laboratory and divided into 2 aliquots, one of which was stored at 4°C and the other at −20°C. Dairy goats enrolled in the present experiment had been through the dry period for 2 mo and did not show any health problems during the experimental period (weekly microbial tests and visual observations were performed for ensuring this statement). Goat colostrum and milk were measured using recording jars at the milking parlor and samples were collected on the first 5 d postpartum and then on selected days (d 15, 30, 60, and 90).

Proximal Composition

Fat, protein, lactose, colostrum DM and SNF, and milk content were determined by routine laboratory procedures using the automated infrared method (DMA2001 Milk Analyzer; Miris Inc., Uppsala, Sweden).

Physical Properties

The pH of the undiluted colostrum and milk was determined using a portable pH meter (Jenco model 6009 portable pH meter; Jenco Instruments Inc., San Diego, CA); pH determinations were made in triplicate. The density of the undiluted colostrum and milk was determined using a portable densitometer with a range between 1,000 to 1,100 g/L (Alla; Alla S.A., Madrid, Spain); density determinations were made in triplicate. The ethanol stability (**ES**) was determined according to Tsioulpas et al. (2007). The strongest concentration of ethanol that did not cause coagulation was defined as the ES. For the determination of acidity, titratable acidity analysis was performed. One milliliter of phenolphthalein indicator (concentrated) was added to 10 mL of milk and the mixture was titrated with 0.111 *M* NaOH to a permanent faint pink color, which was the titration endpoint (pH 8.3). For rennet-clotting time (**RCT**) evaluation, 5 mL of milk was poured into a glass test tube and maintained in a 30°C water bath. The sample was left at 30°C for 10 min and then 100 μL of freshly prepared rennin at 0.1 mg/mL (Sigma-Aldrich, St. Louis, MO) was added. The time (min) from thorough mixing to the first sign of sudden breakdown of the film on the test tube wall was measured and defined as the RCT. The SCC was determined using a DeLaval somatic cell counter (DeLaval International AB, Tumba, Sweden) immediately after samples were obtained, with a soak time of 1 min before the count, following the instructions of Sanchez-Macias et al. (2010a).

Immunological Parameters

IgG, IgA and IgM quantifications in colostrum and milk were performed using goat IgG, IgA, and IgM ELISA kits (Bethyl Laboratories, Montgomery, TX). Chitotriosidase (**ChT**) activity was measured according to Argüello et al. (2008) by incubating 1 μL of undiluted colostrum or milk with 100 μL of a 22 m*M* solution of an artificial substrate (4-methylumbelliferyl-d-N,N′,N″ triacetylchitotriose) in 0.5 *M* citrate phosphate buffer (pH 5.2) 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 with a fluorometer (PerkinElmer, Norwalk, CT), at 365-nm excitation and 450-nm emission. The ChT activity is expressed as nanomoles of substrate hydrolyzed per milliliter per hour.

Statistical Analysis

Statistical analyses were performed using SAS (version 9.00; SAS Institute Inc., Cary, NC). The SAS MIXED procedure for repeated measurements was used to evaluate the effect of postpartum time on the immune and physical parameters and proximate composition on colostrum and milk samples. The Tukey test was used to evaluate the differences during the evolution time at a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Proximal Composition

The proximal composition is displayed in Table 1. Argüello et al. (2006) reported similar values and evolution in the same breed at 5 d postpartum. Fat percentage at partum was higher than d 2 and the following days. The fat percentage remained high until d 5 and reached normal milk goat fat percentage at d 15, in accordance with previous results for the same breed