**A Study on the Change in Postpartum Immunoglobulins of Goats and Kids\***

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**ABSTRACT**

**Objective:** In the study, the changes in the immunoglobulin levels of the Saanen goats fed with colostrum were determined during the three days after birth.

**Material and Methods:** The animal material of the research consists of 11 goats and 11 of their kids. Colostrum samples were taken from the goats in three repetitions (at birth, at 24th and 48th hours after birth). Changes in IgA, IgM, and IgG levels were examined individually in 33 (11 x 3) colostrum samples taken at birth and 24th and 48th hours after birth.

**Results:** IgA, IgM and IgG levels at birth and 24 and 48 hours after birth for Saanen goats were 0.11-1.98-1.88 mg/ml, 0.28-0.95-14.01 mg/ml and 0.25-0.96-13.53 mg/ml, respectively. The IgA, IgM, IgG levels of kids at birth, 24, and 48 hours after birth were 0.76-1.11-19.22 mg/ml, 0.58-1.02-18.42 mg/ml and 0.53-1.24-21.60 mg/ml, respectively. The effect of birth type and gender and parity on IgA, IgM, and IgG levels were not significant, while the effect of the time-dependent change was linearly and quadratically significant (P <0.01).

**Conclusion:** In the colostrum secreted in the postpartum period in goats, it is necessary for the immune substances to be taken as soon as possible since the rate of passage of the immune substances transferred through the intestinal epithelium by this way decreases in time.

**Keywords:** Saanen goat, colostrum intake, immune system, goat milk composition

**Keçi ve Oğlaklarda Doğum Sonrası İmmünoglobulinlerin Değişimi**

**Üzerine Bir Araştırma**

**ÖZ**

**Amaç:** Bu araştırmada; doğumu izleyen üç gün boyunca kolostrumla beslenen Saanen oğlaklarında kolostrumda bulunan bağışıklık maddelerinin değişimi belirlenmiştir.

**Materyal ve Metot:** Araştırmanın hayvan materyalini; 11 baş saf Saanen keçisi ile bunlardan doğan 11 baş oğlak olmak üzere toplam 22 baş hayvan oluşturmaktadır. Her keçiden toplam 3 kez (doğumda ve izleyen 24. ve 48. saatte) kolostrum örneği alınmıştır. Çalışmada, doğum, 24. ve 48. saatte alınan toplam 33 (11 x 3 ) ağız sütü (kolostrum) örneğinde IgA, IgM, IgG düzeylerinin değişimleri bireysel olarak incelenmiştir.

**Bulgular:** Saanen keçilerinde IgA, IgM, IgG düzeyleri doğumda; 0.11-1.98-1.88mg/ml, 24 saat sonra 0.28-0.95-14.01 mg/ml ve 48 saat sonra 0.25-0.96-13.53 mg/ml değerleri arasında değişmiştir. IgA, IgM, IgG nin oğlak kanlarında doğum, 24 ve 48. saatlerdeki düzeyleri sırasıyla; 0.76-1.11-19.22 mg/ml, 0.58-1.02-18.42 mg/ml ve 0.53-1.24-21.60 mg/ml değerleri arasında değişmiştir. IgA, IgM, IgG düzeyleri üzerinde oğlak doğum tipi, ve cinsiyeti ile laktasyon sırasının etkisi önemsiz, zamana bağlı olarak değişimin etkisi gerek lineer gerekse kuadratik olarak önemli bulunmuştur (P<0.01).

**Sonuç:** Keçilerde doğum sonrası dönemde salgılanan kolostrumda yavruya bu yolla aktarılan bağışıklık maddelerinin bağırsak epitel dokudan geçiş hızı azaldığı için oğlakların bağışıklık maddelerinin en kısa sürede alması sağlanmalıdır.

**Anahtar sözcükler**: Saanen keçi, kolostrum tüketimi, bağışıklık sistemi, keçi sütü bileşimi,

**INTRODUCTION**

In recent years, the importance placed on small ruminants has increased in comparison to other domestic animals (Lerias et al. 2014). In developing countries, small ruminant dairy farms have been applying artificial rearing methods, depending on the increase in marketable milk amount (Morales et al. 2014). There are three critical periods in the newborn ruminants’ immune system development during the first two months after birth (Sherman et al. 1990), which are the colostrum-feeding period, milk-feeding period and the post-weaning period, respectively. Flock management methods applied during these periods affect the growth performance of animals (Demirören et al. 1995; Mastellone et al. 2011).

Colostrum consumption and colostrum consumption amount during the first 72 hours are critical in the transfer of passive immune substances to ruminant farm animals, such as, cow, sheep and goat, and in the resultant viability of the offspring (Stelwagen et al. 2009; Hernandez et al. 2014a). This is due to the hypogammaglobulinemia of the offspring. Artificially reared offspring may require bottle-feeding during the first couple of days postpartum to allow sufficient immunoglobulin intake through colostrum consumption (Morales et al. 2011). However, the amount and composition of colostrum production vary depending on various factors including feeding type and the number of offspring per a birth (Banchero et al. 2004). Insufficient colostrum intake in lambs and goat kids during the first hours after birth results in increased susceptibility to diseases and increased death rates (Ahmad et al. 2000; Novak and Poindron, 2006).

Colostrum feeding time is another factor affecting the immune status, considering the fact that using undernourished offspring as breeding stock may sometimes cause certain problems (Hernandez et al. 2014b). IgG levels are high in the blood during the first 12-36 hours after birth, and for ruminant animals, absorption of IgG in the body, which is transferred to colostrum, is of great importance (Chen et al. 1999). Researches on the effect of possible delays in colostrum intake on immunoglobulins in the bloodstream continue (Ahmadi et al. 2009). Two of the most important variables regarding immunoglobulins are the levels of IgG and IgM in the blood. In newborn goat kids, passive immunity is obtained through colostrum, which protects the animals that were the first to respond to any pathogen type or suspected of carrying infectious diseases (Ahmadi et al. 2009). Until the immune system of the offspring is developed, immunoglobulin level in the blood continues to increase for a certain period and increasing colostrum increases the viability of the offspring (Alves et al. 2015).

In intensive goat dairy farms, goat kids are immediately separated from their mothers to avoid or minimize mother-offspring connection (Ramirez et al. 1996). However, colostrum sanitation is imperative in locations where the risk of goat disease transmission, such as, CAE (caprine arthritis encephalitis), is high (Rachman et al. 2015). It was reported that pasteurization and alternative methods used in colostrum hygiene decreased the IgG amounts in colostrum by 20-30% (Arguello, 2011; Trujilo et al. 2007) and thereby IgG concentration in either lyophilized or atomized colostrum remained unchanged(Castro et al. 2011). On the other hand, it was also reported that this recently highlighted negative condition may be avoided using certain methods. CAE virus can be neutralized through heat treatment to colostrum (Castro et al. 2011), although Ig and other colostrum components are affected by heat and immune system of animals may be hindered. For example, in a study carried out using pasteurized cow colostrum, IgG and lactoferrin density and neutrophil activity were decreased in calves (Aldomy et al. 2014). Morin et al. (2007) in their study on calves, and, Constant et al. (1994), in their study on goat kids, reported insufficient IgG absorption in colostrum. However, whether maternal and exogenous IgG have a synergetic effect on the gamma-globulin concentration of newborn goat kids is not well known. This study aimed to determine the changes in immunoglobulin levels in Saanen goats during colostrum feeding.

**MATERIAL and METHOD**

**Animal Material**

In the study, totally 22 head animals, 11 head Saanen goats and 11 heads Saanen kids were used as experimental materials. This study was conducted to Ege University Animal Research Unit.

**Method**

**Colostrum Feeding to Goat Kids**

After birth, the kids were immediately separated from their mothers and fed colostrum weighing at least 10% of their live weight with feeding bottles. During the first hour postpartum, after the umbilical cords of the goat kids were disinfected, ear tags of the goat kids were placed and their birth weights were individually measured immediately after birth (Marounek et al. 2012; Chigerwe et al. 2005).

**Blood Sample Collection**

To individually determine the changes in IgA, IgM and IgG levels, 2 cc blood samples were taken from the vena jugularis of the goats, starting from at least 3 days prior to birth and during the 4 days after birth, and 1 cc blood samples were taken from the goat kids during the 3 days after birth (Quantispeed goat test, QGT) (Chigerwe et al. 2005).

**Determination of the Colostrum Samples and IgG**

Prior to the first milk feeding to goat kids, 500-ml samples were taken from each goat; then, 500-ml samples were taken from each goat in every 24 hours and thereby, a total of 3 colostrum samples were collected per a goat. The changes in IgA, IgM and IgG levels were individually determined for each colostrum sample, a total of 33 samples collected at the 0th, 24th and 48th hours (Quantispeed goat test, QGT) (Dale et al. 2009).

**Milk Analyses**

The dry matter and fat values of milk were determined in accordance with TS 1018 (anonym, 1989); determination of lactose was carried out by using the photometric method [30]; determination of mineral matter was carried out in accordance with AOAC (2000); determination of ash was carried out by following the method proposed by Kurt et al. (2007); the Kjeldahl method was used in the calculation of protein ratio (Renner, 1993). The determined nitrogen amount was multiplied by 6.38 to calculate the percentage protein amount.

**Data Analyses**

In the study, Repeated Measures Factorial Analysis of Variance was used to determine the difference between birth type, gender and parity with respect to investigated properties. Among the multiple comparison tests, the Duncan test was used to determine the differences between the averages of the days in reference to the variance analysis (Gürbüz ve ark., 2003). In the calculations, SPSS 15 (2007) statistical package program was used.

**RESULTS**

Table 1 shows the means and standard errors of the immunoglobulin amounts in goat colostrum at birth, 24th, and 48 hours after birth.

**Table 1. Mean values and standard errors of the immunoglobulins in goat colostrum**

Immunoglobulin levels in goat colostrum showed that IgM had the highest level in the colostrum at birth, followed by IgG, while IgA had the lowest level. At the 24th hour after birth, IgG level increased and reached 14.016 ml, followed by IgM with 0.958 ml. At the 48th hour after birth, immunoglobulin levels in colostrum followed a similar trend to those at the 24th hour; in other words, IgG had the highest level. Table 2 shows the means and standard errors of the immunoglobulin levels determined in the bloods of goat kids at birth and during the hours following birth.

**Table 2. Mean values and standard errors of the immunoglobulins in goat kid bloods**

In the blood samples of the goat kids, IgA level at birth was 0.76 mg/ml and decreased to 0.58 mg/ml 24 hours after birth and reached 0.53 mg/ml 48 hours after birth; in other words, initially, it rapidly decreased and after 48 hours, its decrease nearly came to a standstill. On the other hand, IgM level first showed a decreasing trend after 24 hours and, then, showed a tendency to increase around the 48th hour. IgG level in the blood samples of the goat kids firstly decreased until the 24th hour after birth and then, by contrast with other immunoglobulins, increased by almost 50% around the 48th hour after birth.

**Table 3. Least square means and standard errors of birth type, gender, parity and time-dependent immunoglobulin changes in goat bloods**

Table 3 shows the significance levels and least square average and standard error of the significance levels of some of the factors affecting the investigated properties of the blood samples obtained from the goats. Among the investigated properties, effects of birth type, kid gender and parity were not significant, whereas the effect of time-dependent changes was both quadratically and linearly significant (P<0.01).

**Table 4. Least square means and standard errors of birth type, gender, parity and time-dependent immunoglobulin changes in goat kid bloods**

Table 4 shows the averages and standard errors of some factors, which were considered to affect the immunoglobulins in goat kid blood.

Among the investigated factors, only the effect of time-dependent changes was significant (P<0.01); the effects of birth type, kid gender and parity were not significant. The changes in immunoglobulin levels in kid blood samples from birth to postpartum were both quadratically and linearly significant (P<0.01).

**Properties of Goat Milk**

Table 5 shows descriptive statistics on the changes in the chemical composition of goat milk occurring after birth.

**Table 5. Some descriptive statistics on the chemical composition of goat milk**

Dry matter, fat, protein, casein, lactose, ash and specific weight values of goat colostrum were determined (Figure 1). The average dry matter value of goat colostrum was 24.28%; dry matter values after 24 hours and 48 hours were 17.26% and 13.24%, respectively. As can be seen in Table 5, dry matter values steadily decreased after birth. Fat values in goat colostrum at birth and 24 and 48 hours after birth were 8.27%, 6.76% and 5.59%, respectively. Average protein values of goat colostrum were 10.55%, 6.09%, and 4.23% at birth, 24 hours after birth and 48 hours, respectively. Protein values decreased by 50% after 48 hours postpartum. Since changes in casein amounts are directly proportionate to changes in protein amounts, casein amount also decreased after birth. The average lactose amount in goat colostrum was 4.86% at birth, whereas it was 3.37% and 2.81% at the 24th hour and 48th hour after birth, respectively. Lactose levels also steadily decreased after birth. At birth, ash value in goat colostrum was 1.18%; at the 24th hour after birth, it was 0.90, and at the 48th hour after birth, it was 0.84%. The difference between the changes in the specific weight values of goat colostrum at birth and in the period after birth was not significant.

**Figure 1. Goat milk and colostrum**

**DISCUSSION and CONCLUSION**

A general review of the results shows that IgG, IgM and IgA levels determined in our study are in agreement with the results reported in the relevant literature (Singh, 2010; Berry and Broughan, 2007; Keskin ve ark., 2007; Rodrigez et al. 2008, 2009). The source of IgM and IgA in colostrum is not well known. In a study on human colostrum (Moro et al. 1985), researchers reported that phagocytes transferred these immunoglobulins. Some researchers (Islam et al. 2006) reported the presence of plasma cells in human colostrum and determined that these cells produced IgM and IgA. However, it is difficult to adapt these results to ruminants because, in addition to differences among species in terms of colostrum composition, pre-birth immunoglobulin transfer to offspring is quite hard (Langer, 2009; Moreno et al. 2012b).

Another measure of the immune system development in animals is the time of first colostrum feeding to offspring, which also affects the future productivity of adult animals (Pakkanen and Aalto, 1997). For ruminant animals, the first 12-36 hours postpartum is of great importance in terms of IgG intake from colostrum (Castro et al. 2011). A delay in this period results in decreased viability and increased susceptibility to diseases (Hernandez et al. 2011).

Colostrum consumption is of great importance in the viability and passive immunity development in new-born animals (Stelwagen et al. 2009; Hernandez et al. 2014a,b). Therefore, especially artificially reared animals should receive a sufficient amount of colostrum (Morales et al. 2011, 2014). However, the amount and composition of colostrum produced by mothers are affected by a variety of environmental factors including feeding and number of offspring per a birth (Besser and Gay, 1994). Another important issue is the decreased viability due to insufficient colostrum intake during the first couple of hours after birth, which may cause increased death rates (Quigley and Drewry, 1998). Therefore, supplying the most appropriate colostrum source is of great importance. Some studies have focused on using cow milk as the colostrum source in lamb and goat kid rearing (Quigley et al. 2000,2002); however, the most important risk in here is the risk posed by iron deficiency, which may result in anaemia (Rodriguez et al. 2009). Therefore, for the easy transfer of immunoglobulins to offspring, species-specific colostrum should be provided to each species (Korhonen, 1998). The most important change in immunoglobulin levels occur in IgG and IgM. Goat kid death rate is closely associated with the IgG level in blood (Moreno et al. 2012a). In addition to optimum colostrum amount and composition, optimum temperature, humidity and hygiene conditions should also be provided.

In goat kids, there is a correlation between birth weight and IgG level in blood (Rodriguez et al. 2008). IgG levels in the animals with birth weights below 2.5 kg are especially low during the 12-84 hours after birth (Arguello et al. 2005). In 2000, Arguello et al. (2004) determined that the effect of birth weight on feeding with colostrum was not significant, whereas, in 1979, Halliday and William (Halliday and Williams, 1979) and, in 2003, Christley et al. (2003) reported that birth weight significantly affected the IgG levels in the blood of the lambs of low-colostrum-producing sheep. In a study on goat kids of French Alps, researchers reported that IgG levels in death goat kids were below 75.1 mg/ml and thereby showed the importance of IgG levels in blood (O’Brien and Sherman, 1993) in healthy goat kids, IgG levels was over 143. mg/ml, while these levels were below 75 mg/ml in dead goat kids.

It was observed that the effect of postpartum period on the chemical composition of goat colostrum was significant. In 1995, in their study on goat colostrum, Hadjipanayiotou (1995) determined that dry matter value at birth was 13.20% and the fat content, protein content and ash content of the goat milk used in the study were 4.26%, 4.90%, and 0.83%, respectively. Marounek et al. (2012) carried out a study on goat colostrum and investigated the properties of goat colostrum during the 30 days after birth. Fat content of the colostrum used in this study varied between 3.48% and 5.67%. The highest fat content was determined at birth in that study. Decreases and increases in the fat content of colostrum were distinguished during the 30-day observation. In 2015, Rachman et al. (2015) studied the colostrum and dry matter amounts in the milk of Peranakan Etawah, Saanen and Jawarandu goat genotypes and determined that dry matter amount in Peranakan Etawah colostrum was 38.96% at the first day and it was 37.49% in Jawarandu colostrum and 47.09% in Saanen goats colostrum. In general, dry matter amount in colostrum decreases as the time after birth passes.

In goats, colostrum production and protein ratio in its composition are proportionate to the size of the mammary, in addition to varying depending on species (Marnet and Komara, 2008). Another important issue is the tension occurring due to the secretion level of the alveolar cells in mammary glands and the resultant increase in the time spent to remove the remaining colostrum from the mammary glands. In 2012, Capote et al. (1992) reported that the size of mammary at the first three hours after birth was close to the size of the mammary of Tinerfena genotype goats at the fourth week of lactation. However, in 2003, in their study on cow colostrum, Ontsouka et al. (2011) reported that protein levels in the mammary glands were higher than those in colostrum. This is attributed to the high levels of IgG in total protein. The immunoglobulin levels found in our study (IgG, IgM, IgA) are in agreement with the results reported in the relevant literature. In 1974, Linzell and Peaker (1974) and Arguello et al. (2006a, 2008) reported that the fat content of colostrum increased after 24 hours postpartum and attributed this to the higher levels of fat in the remaining milk as a result of the high amounts of milk removed from mammary glands. The change in the lactose content of colostrum is similar to the change in fat and protein contents. This change is in agreement with the results reported by Hadjipanayiotou (1995), Arguello et al. (2004), Moreno-Indias et al. (2012a,b) and Piccone et al. (2011b).

In conclusion, the immunoglobulin levels in the blood do not change with changing birth weight, colostrum source and first colostrum intake time, whereas, during the days following the birth, the amount of immunoglobulin intake per live weight is significant. In other words, feeding goats with 80 mg/ml IgG-containing colostrum or milk substitute feeds will have double the effect of feed containing low levels of IgG. For this purpose, flock management applications after birth should be improved and the offspring should immediately receive sufficient amounts of immunoglobulins. In the rearing of newborn goat kids, colostrum weighing minimum 10% of the birth weight should be immediately fed to kids.

**REFERENCES**

Lerias JR, Hernandez Castellano LE, Suarez-Trujillo A, Castro N, Pourlis A, Almeida AM. 2014. The mammary gland in small ruminants; Major morphological and functional events underlying milk production. *J Dairy Res*, 81, 304–318.

Morales-delaNuez A, Moreno-Indias I, Sanchez-Macias D, Hernandez-Castellano L E, Suarez-Trujillo A, Assuncao P, Arguello A, Castro N, Capote J. 2014. Effects of Crypthecodinium cohnii, Chlorela spp and Isochrysis galbana addition to milk replacer on goat kids and lambs growth. *J Appl Anim Res*, 42, 213–216.

Sherman DM, Arendt TD, Gay JM, Maefsky VA. 1990. Comparing the effects of four colostrum preparations on serum IgG levels of newborn kids. *Vet Med*, 85, 908–913.

Demiroren E, Shrestha JNB, Boylan WJ. 1995. Breed and environmental effects on components of ewe productivity in terms of multiple births, artificial rearing and 8-month breeding cycles. *Small Rumin Res*, 16, 239–249.

Emsen E, Yaprak M, Bilgin OC, Emsen B, HW Ockerman. 2004. Growth performance of Awassi lambs fed calf milk replacer. *Small Rumin Res*, 53, 99–102.

Mastellone V, Massimini G, Pero ME, Cortese L, Piantedosi D, Lombardi P, Britti D, Avallone L. 2011. Effects of passive transfer status on growth performance in buffalo calves. *Asian Aust J Anim Sci*, 24, 952–956.

Stelwagen K, Carpenter E, Haigh B, Hodgkinson A, Wheeler TT. 2009. Immune components of bovine colostrum and milk. *J Anim Sci,* 87(Suppl.), 3–9.

Hernandez-Castellano LE, Almeida AM, Castro N, Arguello A. 2014a. The colostrum proteome, ruminant nutrition and immunity. *Curr Protein Pept Sci*, 15, 64–74.

Morales-delaNuez A, Moreno-Indias I, Sanchez-Macias D, Capote J, Juste MC, Castro N, Hernandez-Castellano LE, Arguello A. 2011. Sodium dodecyl sulphate reduces bacterial contamination in goat colostrum without negative effects on immune passive transfer in goat kids. *J Dairy Sci*, 94, 410–415.

Banchero GE, Quintans G, Martin GB, Lindsay DR, Milton JT. 2004. Nutrition and colostrum production in sheep. Metabolic and hormonal responses to a high energy supplement in the final stages of pregnancy. *Reprod Fertil Dev*, 16, 633–643.

Ahmad R, Khan A, Javed MT, Hussain I. 2000. The level of immunoglobulins in relation to neonatal lamb mortality in Pak-Karakul sheep. *Vet Arhiv*, 70, 129–139.

Nobrega MA, Ovcharenko I, Afzal V, Rubin EM. 2003. Scanning human gene deserts for long-range enhancers. *Science* 302, 413.

Nowak R, Poindron P. 2006. From birth to colostrum, Early steps leading to lamb survival. *Reprod Nutr Dev*, 46, 431–446.

Hernandez-Castellano LE, Almeida AM, Ventosa M, Coelho AV, Castro N, Arguello A. 2014b. The effect of colostrum intake on blood plasma proteome profile in newborn lambs: Low abundance proteins. *BMC Vet Res*, 10, 85.

Chen JC, Chang CJ, Peh HC, Chen SY. 1999. Serum protein levels and neonatal growth rate of Nubian goal kids in Taiwan area. *Small Rumin Res*, 32, 153–160.

Ahmadi M, Velciov A, Riviş A, Traşcă T, Hărmănescu M, Antoanela C, Scurtu M. 2009. Physico-chemical and Nutritional Characterization of Bovine Colostrum, 16th Symposium on Analytical and Environmental Problems, 28 September SZAB Szeged, Hungary. 430- 433.

Alves AC, Alves NG, Ascari IJ, Junqueira FB, Coutinho AS, Lima RR, Perez JRO, De Paula SO, Furusho-Garcia IF, Abreu LR. 2015. Colostrum composition of Santa Ines sheep and passive transfer of immunity to lambs, *J Dairy Sci*, 68(6): 3706-3716.

Ramirez A, Quileys A, Hevia ML, Sotillo F, Ramirez MC. 1996. Influence of forced contact on the maternal filial bond in the domestic goat after different periods of postpartum separation. *Small Rumin Res,* 23, 75–81.

Rachman AB, Maheswari RRA, Bachroem MS. 2015. Composition and Isolation of Lactoferin from Colostrum and Milk of Various Goad Breeds. *Procedia Food Sci*, 3, 200-210.

Arguello A. 2011. Trends in goat research. *J Appl Anim Res*, 39, 429–434.

Trujillo AJ, Castro N, Quevedo JM, Arguello A, Capote J, Guamis B. 2007. Effect of heat and high pressure treatments on microbiological quality and immunoglobulin G stability of caprine colostrum. *J Dairy Sci*, 90, 833–839.

Castro N, Capote J, Bruckmaier RM, Arguello A. 2011. Management effects on colostrogenesis in small ruminants. *J Appl Anim Res*, 39, 85–93.

Ruiz P, Sesena S, Rieiro I, Llanos PM. 2014. Effect of postpartum time and season on physic chemical characteristics of Murcia-Granada goat colostrum, *Int J Diary Tech*, 68(1): 88-96.

Aldomy Hussein NO, Sawalha L, Khatatbeh K, Aldomy A. 2009. A national survey of perinatal mortality in sheep and goats in Jordan. *Pak Vet J*, 29, 102–106.

Marounek M, Pavlata L, Misurova L, Volek Z, Dvorak R. 2012. Changes in the composition of goat colostrum during the first month of lactation, *Czech J Anim Sci*, 57(1): 28-33.

Suraya MS, Yaakub H. 2011. Effect of colostrum feeding on the serum immunoglobulin level in Saanen crossbred kids. *Mal. J Anim Sci*, 14, 25-29.

Chigerwe M, Dawes ME, Tyler JW, Middleton JR, Moore MP, Nagy DM. 2005. Evaluation of a cow-side immunoassay kit for assessing Ig G concentration in colostrum. *J Am Vet Med Assoc*, 27, 129-131.

Dale LG, Stephen DA, Deborah MH. 2009. Failure of passive transfer and effective colostrum management in calves. from [*http://www.larounds.ca/crus/laveng\_120 3.pdf*](http://www.larounds.ca/crus/laveng_120%203.pdf),  *Accessed*:16/11/2009

Anonim. 1981. TS 1018 Çiğ Süt Standardı, Türk Standartları Enstitüsü, Ankara.

Kurt A, Çakmakçı S, Çağlar A: Süt ve mamülleri muayene ve analiz metotları rehberi (9. Baskı). *Atatürk Üniversitesi Ziraat Fakültesi Yayınları*, No: 18, 254s, Erzurum, 2007.

Renner E. 1993. Practical handouts to the milk, *Justus Liebig Universitat, Germany*, 76.

Gürbüz F, Başpınar E, Çamdeviren H, Keskin S. 2003. Tekrarlanan ölçümlü deneme düzenlerinin analizi. *Yüzüncü Yıl Üniversitesi Matbaası, Van.*

Singh AK. 2010. Studies on immune functions and metabolic status of growing buffalo calves in response to colostral immunoglobulins. *MSc Thesis submitted to NDRI Deemed University*, Karnal (Haryana), India.

Berry E, Broughan J. 2007. Use of the DeLaval cell counter (DCC) on goats’ milk. *J Dairy Res*, 74(3): 345-348.

Keskin M, Güler Z, Gül S, Biçer O. 2007. Changes in Gross Chemical Compositions of Ewe and Goat Colostrum during Ten Days Postpartum. *J App Anim Res*, 32(1): 25-28.

Rodriguez AB, Landa R, Bodas R, Prieto N, Mantecon AR, Giraldez FJ. 2008. Effect of rearing system carcass and meat quality Assaf milk fed lambs: *Meat Sci*, 80, 225–230.

Rodriguez C, Castro N, Capote J, Morales-dela Nuez A, Moreno-Indias I, Sanchez-Macias D, Arguello A. 2009. Effect of colostrum immunoglobulin concentration on immunity in Majorera goat kids. *J Dairy Sci*, 92, 1696–1701.

Moro I, Abo T, Crago SS, Komiyama K, Mestecky J. 1985. Natural killer cells in human colostrum. *Cell Immunol*, 93, 467– 474.

Islam N, Ahmed L, Khan NI, Huque S, Begun A, Yunus ABM. 2009. Immune components (IgA, IgM, IgG immune cells) of colostrum of Bangladeshi mothers. *Pediatr Int*, 48(6): 543–548.

Langer, P. 2009. Differences in the composition of colostrum and milk in eutherians reflect differences in immunoglobulin transfer. *J Mammal*, 90, 332–339.

Moreno-Indias, I, Sanchez-Macias D, Castro N, Morales-delaNuez A, Hernandez-Castellano LE, Capote J, Arguello A. 2012b. Chemical composition and immune status dairy goat colostrum fractions during the first 10h after partum. *Small Rumin Res*, 103, 220-224.

Pakkanen R, Aalto J. 1997. Growth factors and antimicrobial factors of bovine colostrum. *Intl Dairy J*, 7, 285–297.

Hernandez-Castellano LE, Torres A, Alavoine A, Ruiz-Diaz MD, Arguello A, Capote J, Castro N. 2011. Effect of milking frequency on milk immunoglobulin concentration (IgG, IgM and IgA) and chitotriosidase activity in Majorera goats. *Small Rumin Res*, 98, 70–72.

Besser TE, Gay CC. 1994. The importance of colostrum to the health of the neonatal calf. *Vet. Clin North Am. Food Anim Prac*, 10, 107–117.

Quigley JD, Drewry JJ. 1998. Nutrient and immunity transfer from cow to calf pre- and post-calving*. J Dairy Sci,* 8, 79–90.

Quigley JD, French P, James RE. 2000. Effect of pH on absorption of immunoglobulin G in neonatal calves. *J Dairy Sci*, 83, 1853–1855.

Quigley JD, Carson AF, Polo J. 2002. Immunoglobulin derived from bovine plasma as a replacement for colostrum in newborn lambs. *Vet Ther*, 3, 262–269.

Korhonen H. 1998. Colostrum immunoglobulins and the complement system potential ingredients of functional foods. *Bulletin Intl Dairy Fed*, 336, 36–40.

Moreno-Indias I, Morales-delaNuez A, Hernandez-Castellano LE, Sanchez-Macias D, Capote J, Castro N, Arguello A. 2012a. Docosahexaenoic acid in the goat kid diet: Effects on immune system and meat quality. *J Anim Sci*, 90, 3729–3738.

Arguello A, Castro N, Alvarez S, Capote J. 2005. Effects of the number of lactations and litter size on chemical composition and physical characteristics of goat colostrum. *Small Rum Res*, 64, 53-59.

O’Brien J, Sherman D. 1993. Serum immunoglobulin concentrations of newborn goat kids and subsequent kid survival through weaning. *Small Rumin Res*, 11, 71-77.

Marnet PG, Komara M. 2008. Management systems with extended milking intervals in ruminants: regulation, production, and quality of milk. *J Anim Sci.* 86, 47–56.

Arguello A, Castro N, Alvarez S, Capote J. 2006a. Effects of the number of lactations and litter size on chemical composition and physical characteristics of goat colostrum. *Small Rumin Res* 64, 53–59.

Arguello A, Castro N, Batista M, Moreno-Indias I, Morales-DelaNuez A, Sanchez-Macias D, Quesada E, Capote J. 2008. Chitotriosidase activity in goat blood and colostrum. *J Dairy Sci*, 91, 2067–2070.

Hadjipanayiotou M. 1995. Composition of ewe, goat and cow milk and of colostrum of ewes and goats. *Small Rumin Res*, 18, 255-262.

Arguello A, Castro N, Capote J. 2004. Growth of milk replacer kids fed under three different managements. *J Appl Anim Res,* 25, 37–40.

Official Methods of Analysis of AOAC: [*http://www.aoac.org/aoac\_prod\_imis/AOAC/Publications/Official\_Methods\_of\_Analysis/AOAC\_Member/Pubs/OMA/AOAC\_Official\_Methods\_of\_Analysis.aspx?hkey=5142c478-ab50-4856-8939-a7a491756f48*](http://www.aoac.org/aoac_prod_imis/AOAC/Publications/Official_Methods_of_Analysis/AOAC_Member/Pubs/OMA/AOAC_Official_Methods_of_Analysis.aspx?hkey=5142c478-ab50-4856-8939-a7a491756f48)*,* 2000, *Accessed: 01.07.2016*

Piccione G, Scianò S, Messina V, Casella S, Zumbo A. 2011b. Changes in serum total proteins, protein fractions and albumin-globulin ratio during neonatal period in goat kids and their mothers after parturition. *Ann Anim Sci*, 11, 251–260.

Arguello A. 2000. Artificial rearing of kids. Colostrum feed, growth, carcass quality and meat quality. *PhD Thesis* Las Palmas de Gran Canary University, Spain.

Capote J, Darmanin N, Delgado JV, Fresno MR, Lo´pez JL. 1992. Agrupacio´n Caprina Canaria Ed. *Consejerı´a de Agricultura y Pesca del Gobierno de Canarias*, Canary Islands, Spain.

Castro N, Capote J, Alvarez S, Arguello A. 2005. Effects of lyophilized colostrum and different colostrum feeding regimens on passive transfer of immunoglobulin G in Majorera goat kids. *J Dairy Sci*, 88, 3650–3654.

Christley RM, Morgan KL, Parkin TDH, French NP. 2003. Factors related to the risk of neonatal mortality, birth-weight and serum immunoglobulin concentration in lambs in the UK*. Prev Vet Med*, 57, 209–226.

Constant SB, LeBlanc MM, Klapstein EF, Beebe DE, Leneau HM, Nunier CJ. 1994. Serum immunoglobulin G concentration in goat kids fed colostrum or a colostrum substitute. *J Am Vet Med Assoc*, 205, 1759–1762.

Halliday R, Williams MR. 1979. Absorption of immunoglobulin from colostrum by bottle-fed lambs. *Ann Rech Vet*, 10, 549–556.

Linzell JL, Peaker M. 1974. Changes in colostrum composition and in the permeability of the mammary epithelium at about the time of parturition in the goat. *J Physiol*, 243, 129-151.

Morin DE, McCoy GC, Hurley WL. 1997. Effects of quality, quantity, and timing of colostrum feeding and addition of a dried colostrum supplement on immuno- globulin G1 absorption in Holstein bull calves. *J Dairy Sci*, 80, 747–753.

Ontsouka QRU, Bruckmaier J, Blum W. 2003. Fractionized milk composition during removal of colostrum and mature milk. *J Dairy Sci*, 86, 2005- 2011.

SPSS 15. 2007. Veri Analiz Yöntemleri. Eymen, U.E. İstatistik Merkez Yayın No:1.

Table 1. Mean values and standard errors of the immunoglobulins in goat colostrum

Çizelge 1. Keçi kolostrumunda immünoglobulinlerin ortalama değerleri ve standart hataları

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Time** | **Investigated Properties** | **N** | **Mean (**mg/ml) | **Standard error** |
|  | IgA | 11 | 0.1105 | 0.179 |
| **At birth** | IgM | 11 | 1.9870 | 0.025 |
|  | IgG | 11 | 1.8850 | 0.041 |
|  | IgA | 11 | 0.2850 | 0.078 |
| **24 hours after birth** | IgM | 11 | 0.9580 | 0.031 |
|  | IgG | 11 | 14.0160 | 0.027 |
|  | IgA | 11 | 0.2535 | 0.435 |
| **48 hours after birth** | IgM | 11 | 0.9640 | 0.017 |
|  | IgG | 11 | 13.5395 | 0.089 |

IgA: Immunoglobulin A IgM: Immunoglobulin M IgG: Immunoglobulin G

Table 2. Mean values and standard errors of the immunoglobulins in goat kid bloods

Çizelge 2. Oğlak kanındaki immünoglobulinlerin ortalama değerleri ve standart hataları

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampling Time** | **Investigated Properties** | **N** | **Mean** (mg/ml) | **Standard error** |
|  | IgA | 11 | 0.7664 | 0.253 |
| **At birth** | IgM | 11 | 1.1191 | 0.050 |
|  | IgG | 11 | 19.2295 | 0.025 |
|  | IgA | 11 | 0.5895 | 0.591 |
| **24 hours postpartum** | IgM | 11 | 1.0295 | 0.046 |
|  | IgG | 11 | 18.4282 | 0.026 |
|  | IgA | 11 | 0.5314 | 0.535 |
| **48 hours postpartum** | IgM | 11 | 1.2482 | 0.038 |
|  | IgG | 11 | 21.6091 | 0.026 |

IgA: Immunoglobulin A IgM: Immunoglobulin M IgG: Immunoglobulin G

Table 3. Least square means and standard errors of birth type, gender, parity and time-dependent immunoglobulin changes in goat bloods

Çizelge 3. Keçi kanında doğum türü, cinsiyet, parite ve zamanın immünoglobulin değişikliği üzerine en küçük kareler ortamaları ve standart hataları

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Effects** | **n** | **IgA** (mg/ml) | **IgM(**mg/ml) | **IgG(**mg/ml) |
| **Birth Type**  Single  Twins | 5  6 | **NS**  0.176 ± 0.026  0.264 ± 0.025 | **NS**  1.358 ± 0.048  1.283 ± 0.046 | **NS**  9.597 ± 0.374  9.799 ± 0.361 |
| **Gender**  Male  Female | 5  6 | **NS**  0.182 ± 0.034  0.259 ± 0.040 | **NS**  1.387 ± 0.062  1.254 ± 0.074 | **NS**  10.261 ± 0.485  9.134 ± 0.563 |
| **Parity**  2  3  4 | 3  3  5 | **NS**  0.182 ± 0.032  0.114 ± 0.048  0.165 ± 0.044 | **NS**  1.162 ± 0.059  1.414 ± 0.048  1.385 ± 0.080 | **NS**  9.311 ± 0.462  9.381 ±0.689  10.581 ± 0.623 |
| **Time(hour)**  0  24  48  *Linear*  *Quadratic* | 11  11  11 | 0.111 ± 0.020  0.295 ± 0.027  0.255 ± 0.017  **\*\***  **\*\*** | 1.978 ± 0.039  0.953 ± 0.019  1.029 ± 0.069  **\*\***  **\*\*** | 1.820 ± 0.072  13.730 ± 0.534  13.543 ± 0.232  **\*\***  **\*\*** |
| **GENERAL** | 11 | 0.220 ± 0.018 | 1.320 ±0.032 | 9.698 ± 0.250 |

\*\*: (P<0.01) NS: Not Significant

Table 4. Least square means and standard errors of birth type, gender, parity and time-dependent immunoglobulin changes in goat kid bloods

Çizelge 4. Oğlak kanında doğum türü, cinsiyet, parite ve zamanın immünoglobulin değişikliği üzerine en küçük kareler ortamaları ve standart hataları

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Effects | n | IgA**(**mg/ml) | IgM**(**mg/ml) | IgG**(**mg/ml) |
| **Birth Type**  Single  Twins | 5  6 | **NS**  0.586 ± 0.111  0.649 ± 0.073 | **NS**  1.141 ± 0.041  1.124 ± 0.035 | **NS**  19.295 ± 0.961  20.009 ± 0.818 |
| **Gender**  Male  Female | 5  6 | **NS**  0.586 ± 0.111  0.650 ± 0.126 | **NS**  1.134 ± 0.053  1.131 ± 0.060 | **NS**  18.382 ± 1.240  20.922 ± 1.409 |
| **Parity**  2  3  4 | 3  3  5 | **NS**  0.681 ± 0.106  0.554 ± 0.140  0.618 ± 0.142 | **NS**  1.091 ± 0.051  1.163 ± 0.067  1.146 ± 0.068 | **NS**  19.999 ± 1.185  19.905 ± 1.568  19.052 ± 1.586 |
| **Time(hour)**  0  24  48  *Linear*  *Quadratic* | 11  11  11 | 0.751 ± 0.059  0.575 ± 0.056  0.527 ± 0.047  **\*\***  **\*\*** | 1.111 ± 0.032  1.027 ± 0.032  1.259 ± 0.030  **\*\***  **\*\*** | 19.209 ± 0.683  18.319 ± 0.642  21.429 ± 0.618  **\*\***  **\*\*** |
| GENERAL | 11 | 0.618 ± 0.054 | 1.133 ± 0.026 | 19.652 ± 0.598 |

NS: Not Significant \*\*: (P<0.01)

Table 5. Some descriptive statistics on the chemical composition of goat milk

Çizelge 5. Keçi sütünün kimyasal bileşiminin bazı tanımlayıcı istatistikleri

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Period/time** | **Investigated Property** | **N** | **Minimum** | **Maximum** | **Average** | **Standard Error** |
|  | Dry matter (%) | 11 | 18.88 | 29.08 | 24.28 | 0.95 |
|  | Fat (%) | 11 | 5.70 | 9.85 | 8.27 | 0.43 |
|  | Protein (%) | 11 | 7.04 | 15.32 | 10.55 | 0.78 |
| **At birth** | Casein (%) | 11 | 4.76 | 12.14 | 7.80 | 0.67 |
|  | Lactose (%) | 11 | 3.79 | 5.83 | 4.86 | 0.20 |
|  | Ash (%) | 11 | 0.82 | 2.07 | 1.18 | 0.10 |
|  | Specific weight (gr) | 11 | 1.029 | 1.074 | 1.04 | 0.01 |
|  | Dry matter (%) | 11 | 13.76 | 23.07 | 17.26 | 0.77 |
|  | Fat (%) | 11 | 5.30 | 8.75 | 6.76 | 0.37 |
| **24 hours postpartum** | Protein (%) | 11 | 3.81 | 8.72 | 6.09 | 0.43 |
|  | Casein (%) | 11 | 3.08 | 6.91 | 4.70 | 0.14 |
|  | Lactose (%) | 11 | 2.58 | 4.30 | 3.37 | 0.03 |
|  | Ash (%) | 11 | 0.82 | 1.14 | 0.90 | 0.01 |
|  | Specific weight (gr) | 11 | 1.024 | 1.040 | 1.030 | 0.25 |
|  | Dry matter (%) | 11 | 12.33 | 14.83 | 13.24 | 0.26 |
|  | Fat (%) | 11 | 3.20 | 7.50 | 5.59 | 0.43 |
| **48 hours postpartum** | Protein (%) | 11 | 2.76 | 5.06 | 4.13 | 0.22 |
|  | Casein (%) | 11 | 2.72 | 4.01 | 3.31 | 0.13 |
|  | Lactose (%) | 11 | 2.29 | 3.79 | 2.81 | 0.14 |
|  | Ash (%) | 11 | 0.70 | 1.07 | 0.84 | 0.04 |
|  | Specific weight (gr) | 11 | 1.022 | 1.034 | 1.026 | 0.01 |

Figure 1. Goat milk and colostrum

Şekil 1. Keçi sütü ve kolostrum

