Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 1, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

PHYSICAL-CHEMICAL PARAMETERS OF CARPATHIAN GOAT COLOSTRUM AND MILK

Alexandra MARINA, Stelian DĂRĂBAN, Daniel COCAN, Camelia RĂDUCU, Andrada IHUȚ, Paul UIUIU, Radu CONSTANTINESCU, Vioara MIREȘAN

University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Animal Science and Biotechnologies, 3-5 Mănăştur Street, 400372, Cluj-Napoca, Romania

Corresponding author email: paul.uiuiu@usamvcluj.ro

Abstract

Metabolism, a manifestation specific to life, represents the set of physical and chemical processes through which living matter achieves continuous renewal to function and organize the specific activity. The physical-chemical composition of goat milk is conditioned by breed, individuality, area, and age. This study analyzes the physical-chemical composition of milk from a population of Carpathian goat breed, in the first seven postpartum days (first, third, and seventh day) according to age (primiparous and multiparous) to observe the physical-chemical changes from colostrum to milk. The physical-chemical parameters analyzed were: fat (g/100 g); protein (g/100 g); casein (g/100 g); lactose (g/100 g); solid non-fat - SNF (g/100 g); total dry matter (g/100 g); pH; freezing point (FP); urea mg/dl; somatic cells count - SCC/ml x 1000; total bacteria count - TBC/ml x 1000. Results highlight the intense changes that occur at the physico-chemical level of goat's milk to cover the nutritional requirements of the newborn goat and indicate the health status of the mammary gland.

Key words*: casein, colostrum, fat, metabolism, protein.*

INTRODUCTION

The study of colostrum composition and gradual transition to normal milk is of considerable interest from several points of view. Colostrum indicates the rate at which the epithelial cells gradually take over the function of milk synthesis and also the immune bodies are transferred from the mother to the fetus in association with the globulin fraction of the colostrum, which gives additional importance to the separate analysis of this protein because it passes unchanged from the bloodstream into milk (Woodman, 1921). The first studies performed on the composition of goat colostrum and the transition to normal milk analyzed constituents such as total solid, fat, casein, albumin, globulin, lactose, water, and ash (Bergman & Turner, 1937). Milk protein is one of the most important nutritional components of goat milk (Zhu et al., 2018). In the first five days postpartum, goat milk was considered colostrum because there was a significant difference in the composition of goat milk. After 5 days, it was switched to normal milk when all measured parameters were within normal ranges (Mahmut et al., 2007; Di Chen et al., 2018). The composition of goat colostrum and its evolution to normal milk is essential for the transfer of passive immunity to goat kids and for the development of an optimal formula of milk powder to ensure the nutrient requirements for new-born goat kids in the case of artificial feeding (Constant et al., 1994; Arguello et al., 2004a; Clark et al., 2017). The advantages of artificial feeding are due to the lack of weaning stress which stagnates the growth of the goat kids for 7-8 days. The chemical composition of milk is conditioned by the breed, individuality of the animal, area, age, level, nature of feeding, lactation stage, season, milking duration, and health status (Morand-Fehr et al., 2007). Breed influences goat milk production, when milk or colostrum production is high, the total protein content decreases (Pritchett et al., 1991; Quigley et al., 1994). Evaluation of milk composition showed that two- and three-year-old goats do not have any significant difference in terms of fat, SNF, protein, and lactose. As for four-year-old goats, there are distinct differences in composition where the fat content is extremely high (Ibrahim & Jail, 2022). Somatic cells have no active role in the composition of goat milk and indicate the quality and health of the

mammary gland. The general somatic theory tells us that the number of cells increases with the development of lactation (Poutrel & Lerondelle, 1983). The level of somatic cells is significant for goat milk during the lactation period (Haddadi et al., 2006), and physiological status is insignificant for microbially goat milk quality (Saha, 2022).

MATERIALS AND METHODS

This study aimed to identify the physical-chemical parameters of goat milk in a Carpathian goat population depending on the physiological state, during the first seven days postpartum. The Carpathian goat population under study is located in the area of the Trascău Mountains, Alba County. The study included 10 Carpathian goats at the first lactation (primiparous) and 10 Carpathian goats at the second lactation (multiparous). Milk samples were collected from each specimen belonging to the experimental group at 3 different postpartum periods: first day postpartum, third day postpartum, and seventh day postpartum following the model of Chen, D., who takes the composition of goat milk from a Laoshan goat population throughout the lactation period, with an emphasis on analysis of the first seven days postpartum (Chen et al., 2018; Argüello et al., 2006). The udder was pre-washed with warm water and blotted with a disposable paper towel; the goat milk was milked by hand and it was considered that the milking was complete and hygienic for the accuracy of the analyzed data. The milk sample was homogenized and put in sterile containers (50 ml), to be analyzed the physical-chemical parameters of goat milk: fat (g/100 g); protein (g/100 g); casein (g/100 g); lactose (g/100 g); solid non-fat - SNF (g/100 g); total dry matter (g/100 g); pH; freezing point (FP); urea mg/dL; somatic cells count - SCC/mL x 1000; total bacteria count - TBC/mL x 1000. The milk sample was analyzed with the help of the MilkoScan FT (Foss Electric) which is based on Fourier transform infrared technology and provides a wide range of compositional parameters for milk devices (Sánchez, 2007; Saha et al., 2022). Milkoscan is calibrated according to reference methods: ISO 8968-2/IDF 20-2 for protein (ISO, 2014); ISO 1211/IDF for fat (ISO, 2010); ISO 26462/IDF for lactose (ISO, 2010); ISO 6731/IDF for milk solids (ISO, 1989); ISO 108:2002 for freezing point (IDF, 2002); ISO 14637:2004 for urea and pH (ISO, 2004b). The total bacterial count was determined by flow cytometry method using a BactoScan^{TM} according to ISO 21187:2004 (ISO, 2004) and somatic cells count was determined by Fossomatic FC according to ISO 13366-1:2008 (ISO, 2008). ANOVA one-way was used to determine if there were statistically significant differences between means of groups (intragroup and intergroup), followed by Tukey post-hoc test for multiple comparisons (Chende et al., 2022; Matei-Lațiu et al., 2023). Before performing ANOVA one-way, the normal distribution of data was analyzed. Where data did not follow a normal distribution, the Kruskal-Wallis test was used, seconded by the Dunn test. The threshold for statistical significance was set to $\alpha=0.05$. Data processing was performed in Microsoft Excel for Windows, MS Excel 2016, version 16.0.4266.1001, and GraphPad Prism 8.0.1.

RESULTS AND DISCUSSIONS

Changes in fat content were observed in both primiparous (P) and multiparous (M) groups only when comparing day 1 to day 7 (P-Day 1 vs. P-day 7: P=0.0573 and M-Day 1 vs. M-day 7: P=0.751). Fat content from day 3 and day 7 did not show statistically significant differences (P<0.0001 in both cases). Intergroup comparison (P-Day 1 vs. M-Day 1, P-Day 3 vs. M-Day 3, P-Day 7 vs. M-Day 7,) did not show statistically significant differences (P>0.9999) (p and Figure 1). Fat content is higher in the first days postpartum and remained high until day 5 and reached normal milk goat fat percentage at day 15 (Sánchez-Macías et al., 2014). Compared to mature goat's milk, colostrum has significantly higher contents of protein, fat, minerals, dry matter, and a lower concentration of lactose (Yufang et al., 2021). The stage of lactation had significant effects on the contents of fat, protein, lactose (Kondyli et al., 2007). In general, an increase was observed in protein, fat, ash, SNF, and viscosity, except for lactose and pH, which recorded high values during the first lactation, decreasing until the fourth lactation (Antunac, 2001).

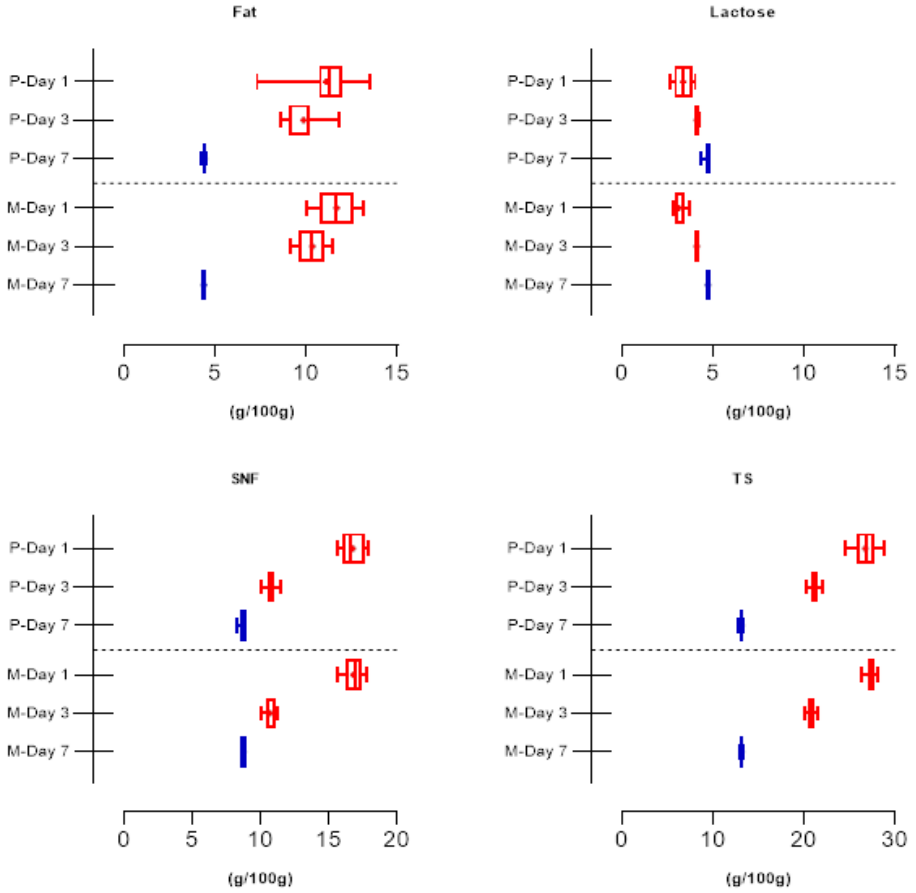

Figure 1. Variations and descriptive statistics of fat, lactose, SNF and TS content determined for primiparous and multiparous group. Red box and whisker plots represent colostrum analysis (day 1 and day 3). Blue box and whisker plots represent milk analysis (day 7). P represents the primiparous group and M represents the multiparous group

Lactose and SNF content registered identical trends to fat content, intragroup analysis showing statistically significant differences only when comparing day 1 to day 7 ($P<0.0001$ both for primiparous and multiparous). Intergroup analysis din dot showed statistically significant differences ($P>0.9999$) (Figure 1).

Ontsouka et al. (2003) observed that lactose production values were lower in colostrum than in mature milk. According to Oltner (1985), we can state that the casein content and urea content in Carpathian goat milk is influenced by the stage of lactation. Lactose content can also be used as an indicator of mammary gland health (Lindmark-Månsson et al., 2006).

The total solids content (TS) presented statistically significant differences in both intragroup analysis (primiparous and multiparous groups) (P-Day 1 vs. P-Day 3; P-Day 1 vs. P-Day 7; P-Day 3 vs. P-Day 7; M-Day 1 vs. M-Day 3; M-Day 1 vs. M-Day 7 and M-Day 3 vs. M-Day 7: $P<0.0001$).

Intergroup analysis (P vs. M) did not show statistically significant differences (P-Day 1 vs. M-Day 1: $P=0.446$; P-Day 3 vs. M-Day 3: $P=0.7307$; P-Day 1 vs. M-Day 1: $P>0.9999$) (Figure 1). SNF content varies slightly during the lactation stage and the change in SNF content is less pronounced, especially in late lactation (Noutfia et al., 2014). Decreasing fat, protein, non-fat dry matter, and total dry matter in the composition of milk decreases milk quality (Peana et al., 2007).

In intragroup analysis protein content from day 1 to day 3 (for both primiparous and multiparous groups) did not show statistically significant

differences (P>0.9999). When intragroup day 1 and day 7 were compared, statistically significant differences were observed (P-Day 1 vs. P-Day 7: P=0.004 and M-Day 1 vs. M-Day 7: P=0.0008). A similar situation was observed when P-Day 3 vs. P-Day 7 (P= 0.0244) and M-Day 3 vs. M-Day 7 (P<0.0001) were analyzed. The intergroup analysis did not show statistically significant differences (P>0.9999) (Figure 2). Other studies show a similar decrease in total protein content in colostrum and total protein levels from different goat breeds (Graf et al., 1970; Linzell and Peaker, 1974). Other studies show a similar decrease in total protein and fat contents in goat colostrum; fat percentage at postpartum was higher than second day and the following days (Arguello et al., 2006; Sánchez-Macías et al., 2014) and total thus concluding that the nutritional requirements of the newborn goat are significantly higher than the nutritional requirements in the growth and fattening process.

Casein and urea content showed statistically significant differences in all intragroup analyses (P<0.0001) but in intergroup analysis, no significant differences were observed (Figure 2). The high casein content in the first postpartum days is explained by its ability to form a coagulum and facilitate the digestion of the newborn goat, observing a regression until the seventh day, when nutritional requirements are no longer as high (Bergman & Turner, 1937). Milk urea has been used as an indicator of the adequacy of the ratio of crude protein to energy intake in animal nutrition. Milk urea is influenced by milk production, age of animals, number of lactations, stage of lactation, and grazing system (Oltner et al., 1985; Carlsson et al., 1995).

The pH levels in the primiparous group were statistically significant (P-Day 1 vs. P-Day 3; P-Day 1 vs. P-Day 7; P-Day 3 vs. P-Day 7: P<0.0001). In the case of the multiparous group, pH levels were statistically significant only in M-Day 1 vs. M-Day 3 and M-Day 1 vs. M-Day 7 intervals (P<0.0001) while in M-Day 3 vs. M-Day 7 interval, no statistically significant differences were observed (Table 1 and Figure 3).

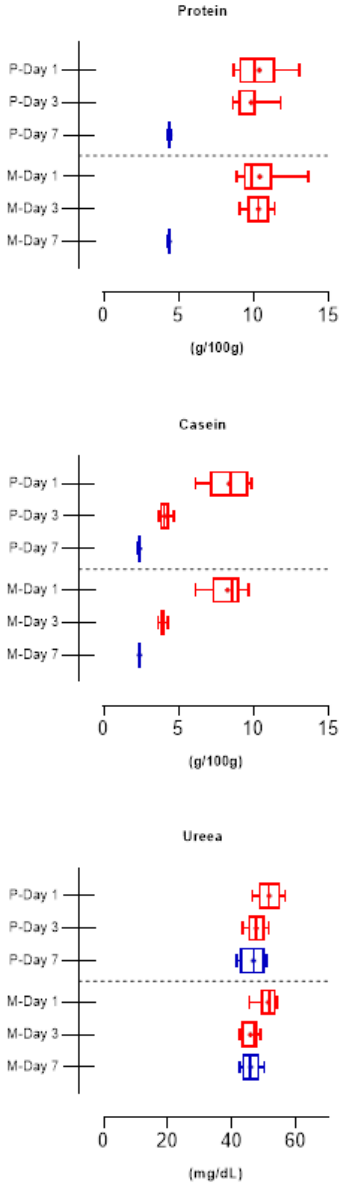

Figure 2. Variations and descriptive statistics of protein, casein, and urea content were determined for the primiparous and multiparous groups. Red Box and whisker plots represent colostrum analysis (day 1 and day 3). Blue box and whisker plots represent milk analysis (day 7). P represents the primiparous group and M represents the multiparous group

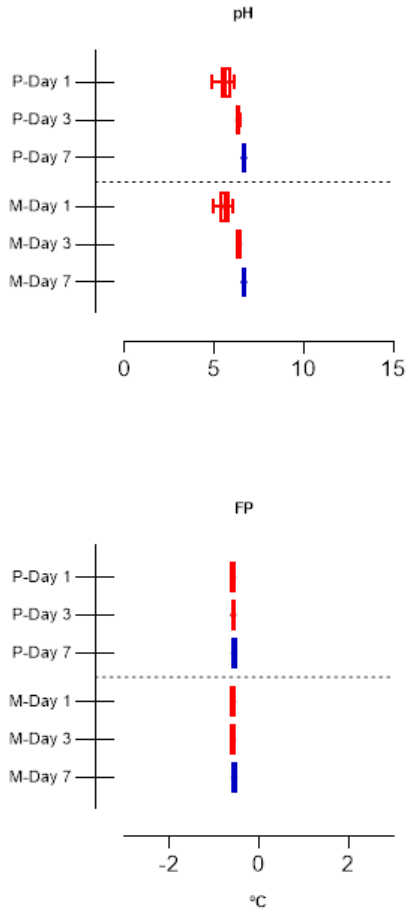

Figure 3. Variations and descriptive pH and FP content were determined for the primiparous and multiparous groups. Red Box and whisker plots represent colostrum analysis (day 1 and day 3). Blue box and whisker plots represent milk analysis (day 7). P represents the primiparous group and M represents the multiparous group

The biochemical components of milk gradually increase from the first lactation to the fourth lactation, except for lactose and pH (Bhosale et al., 2009). pH has a significant effect on the thermal stability of goat milk proteins, and goat milk proteins are the least thermally stable at pH 6.9 (Li et al., 2020).

FP content in the primiparous group did not show statistically significant differences in P-Day 1 vs. P-Day 3 intervals (P>0.9999) while in P-Day 1 vs. P-Day 7 and P-Day 3 vs. P-Day 7 intervals the differences were statistically significant (P=0.0002 respectively P=0.0232). In the multiparous group, FP content showed a similar tendency: M-Day 1 vs. M-Day 3 (P>0.9999), M-Day 1 vs. M-Day 7 (P=0.0025), and M-Day 3 vs. M-Day 7 (P=0.001). The intergroup analysis (primiparous vs. multiparous) did not register significant statistical differences (P>0.9999) (Figure 3). The freezing point (FP) of milk is relatively constant as a consequence of the osmotic balance in milk and blood (Henno et al., 2008), for goat's milk an average reference value of -0.579°C was established (Dharamarajan et al., 1950). Freezing point is significantly influenced by breed, genetic factors (species and breed) as well as non-genetic factors such as feed composition, water intake, milking time, stage of lactation, season, and livestock size (Gencurová et al., 2008; Kędzierska-Matysek et al., 2011).

Bacterial mammary infections are the major cause of increased SCC in dairy goats, but there are a large number of non-infectious factors that can significantly affect SCC in goat milk, such as time between milkings, stage of lactation, number of lactations, and breed (Jiménez-Granado et al., 2014).

The SSC determinations showed significant statistical differences in the primiparous group for all intervals (P-Day 1 vs. P-Day 3: P<0.0001, P-Day 1 vs. P-Day 7: P=0.0006, P-Day 3 vs. P-Day 7: P<0.0001). In the multiparous group statistically, significant differences were observed for M-Day 1 vs. M-Day 3 (P<0.0001) and M-Day 3 vs. M-Day 7 (P<0.0001), while for the interval M-Day 1 vs. M-Day 7, no significant statistical differences were observed (P=0.1145). Intergroup analysis (primiparous vs. multiparous) showed that there were no statistically significant differences (P-Day 1 vs. M-Day 1: P= 0.5499; P-Day 3 vs. M-Day 3: P=0.9964 and P-Day 7 vs. M-Day 7: P>0.9999) (Figure 4). Normal limits of SCC vary between 210 x 1.000 and

1.120 x 1.000 cells/ml in goat milk (Manser, 1986). According to the reference range of SCC in the specialized literature and the results of the analyzes performed on the milk of the Carpathian breed goats, it can be said that the health status of the mammary gland is adequate. In other studies, the lactation stage was shown to have no significant effect on SCC and TBC, and the correlation between these parameters was also non-significant (Kuchtík et al., 2021).

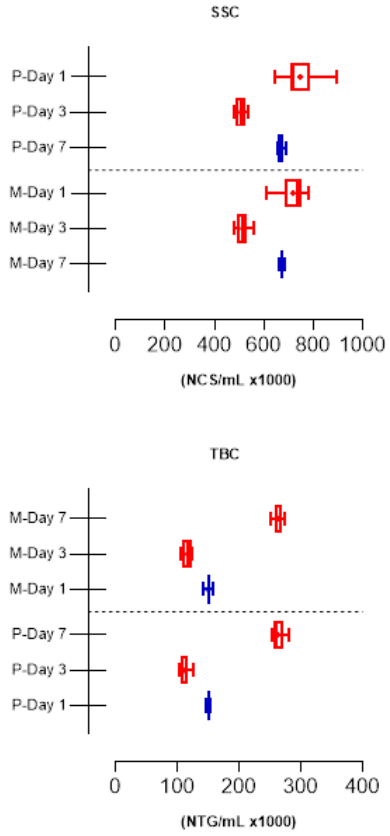

Figure 4. Variations and descriptive statistics of SSC and TBC content determined for primiparous and multiparous group. Red box and whisker plots represent colostrum analysis (day 1 and day 3). Blue box and whisker plots represent milk analysis (day 7). P represents the primiparous group and M represents the multiparous group

TBC is commonly used to assess the bacteriological quality of milk. The goat's milk sampling protocol was strictly followed to obtain the accuracy of the data regarding the bacterial load, so we can state that for the analyzed Carpathian goats TBC was influenced by the period of lactation, but not by their physiological status (primiparous and multiparous). The TBC determinations in both groups (primiparous and multiparous) were statistically significant ($P<0.0001$). Intergroup (primiparous vs. multiparous) analysis did not show statistically significant differences between groups (P-Day 1 vs. M-Day 1: $P>0.9999$; P-Day 3 vs. M-Day 3: $P=0.4856$ and P-Day 7 vs. M-Day 7: $P=0.9855$) (Figure 4). Many studies show that the bacteriological quality of goat milk is mainly influenced by the milking method, water quality, hygiene of milking equipment and storage tanks, hygiene of milkers, milking parlor environment, and transport hygiene (Contreras et al., 2003).

CONCLUSIONS

The physiological status can produce significant changes in the physical-chemical parameters of the milk of Carpathian goats raised in the area of the Trascău Mountains, Alba County, Romania. Changes in Fat, Lactose, and SNF content registered identical trends, with intragroup analysis showing statistically significant differences only when comparing day 1 to day 7, while the intergroup analysis did not show statistically significant differences. Protein content from day 1 to day 3 (for both primiparous and multiparous groups) did not show statistically significant differences but observed statistically significant differences intragroup day 1 and day 7. A similar situation was observed from primiparous Day 3 vs. Day 7. Casein and urea content showed statistically significant differences in all intragroup analyses but in intergroup analysis, no significant differences were observed. The casein and urea content in Carpathian goat milk was influenced by the stage of lactation. FP content in the primiparous group did not show statistically significant differences and in the multiparous group, FP content showed a similar tendency. This tendency shows that the freezing point of milk is relatively constant. The pH levels were statistically significant in the primiparous and multiparous groups, but intergroup there were no statistically significant differences observed. Protein, Casein, SNF, and TS were observed to decrease throughout the seven days studied, except for lactose which showed an increase. The composition of the goat's milk was different in the first three days compared to the parameters of normal milk, which demonstrates the power of the milk to support the nutritional needs of the newborn goat kid. The practical applicability of these data can be translated into milk formula recipes adapted for the Carpathian goat biological requirements.

The stage of lactation had no significant effect on SCC and TB, and the correlation between these traits was also insignificant. The SSC determination and the TBC determinations showed significant statistical differences in both groups (primiparous and multiparous). Intergroup (primiparous vs. multiparous) analysis did not show statistically significant differences. According to the reference range of SCC in the specialized literature and the results of the analyzes performed on the milk of the Carpathian breed goats, it can be said that the health status of the mammary gland is adequate.

REFERENCES

Antunac, N., Samaržija, D., Havranek, J. L., Pavić, V., & Mioč, B. (2001). Effects of stage and number of lactations on the chemical composition of goat milk. *Czech Journal of Animal Science*, 46(12), 548-553.

Argüello, A., Castro, N., Capote, J., Tyler, J.W., Holloway, N.M., 2004a. Effect of colostrum administration practices on serum IgG in goat kids. *Livest. Prod. Sci*. 90, 235–239.

Argüello, A., Castro, N., Alvarez, S., & Capote, J. (2006). Effects of the number of lactations and litter size on chemical composition and physical characteristics of goat colostrum. *Small Ruminant Research*, 64(1-2), 53-59.

Bergman, A. J., & Turner, C. W. (1937). The composition of the colostrum of the dairy goat. *Journal of Dairy Science*, 20, 37-45.

Bhosale, S. S., Kahate, P. A., Kamble, K., Thakare, V. M., & Gubbawar, S. G. (2009). Effect of lactation on physico-chemical properties of local goat milk. *Veterinary world*, 2(1), 17.

Carlsson, J., Bergström, J., & Pehrson, B. (1995). Variations with breed, age, season, yield, stage of lactation and herd in the concentration of urea in bulk milk and individual cow's milk. *Acta Veterinaria Scandinavica*, 36, 245-254.

Chende, A., Miclaus, V., Damian, A., Martonos, C., Rus, V., Matei-Latiu, M. C., C. Latiu, & Gal, A. F. (2022). Mucous non-goblet cells in the small intestine of guinea pigs (Cavia porcellus): a histological and histochemical study. *Folia Morphologica*.

Clark, S., & García, M. B. M. (2017). A 100-year review: Advances in goat milk research. *Journal of dairy science*, 100(12), 10026-10044

Constant, S. B., Leblanc, M. M., Klapstein, E. F., Beebe, D. E., Leneau, H. M., & Nunier, C. J. (1994). Serum immunoglobulin G concentration in goat kids fed colostrum or a colostrum substitute. *Journal of the American Veterinary Medical Association*, 205(12), 1759-1762.

Contreras, A., Luengo, C., Sanchez, A., & Corrales, J. C. (2003). The role of intramammary pathogens in dairy goats. *Livestock Production Science*, 79(2-3), 273-283.

Di, Chen, Xuan, Zhao, Xiangying, Li, Jianmin, Wang, & Cunfang, Wang (2018). Milk compositional changes of Laoshan goat milk from partum up to 261 days postpartum. *Animal Science*, 89(9), 1355-1363.

Dharamarajan, C. S., Venkateswara, R., Menon, M. N., & Dastur, N. N. (1950). Composition of milk of Indian animals. I. Freezing point, lactose, chloride and acidity in the milk of different breeds of animals. Indian *Journal of Veterinary Science*, 20(1), 35-46.

Graf, F., Osterkorn, K., Fautz, J., Frahm, K., & Gall, C. (1970). Calorific value of goats' milk. I. Relationship between fat and calorific value*. Arb. Inst. Tierzucht*, 8, 45-52.

Gencurová, V., Hanus, O., Vyletelová, M., Landová, H., & Jedelská, R. (2008). The relationships between goat and cow milk freezing point, milk composition and properties*. Scientia Agriculturae Bohemica* (Czech Republic).

Granado, R. J., Rodríguez, M. S., Arce, C., & Estévez, V. R. (2014). Factors affecting somatic cell count in dairy goats: a review. *Spanish Journal of Agricultural Research*, (1), 133-150.

Haddadi, K., Prin-Mathieu, C., Moussaoui, F., Faure, G. C., Vangroenweghe, F., Burvenich, C., & Le Roux, Y. (2006). Polymorphonuclear neutrophils and Escherichia coli proteases involved in proteolysis of casein during experimental E. coli mastitis. *International Dairy Journal*, 16(6), 639-647.

Henno, M., Ots, M., Jõudu, I., Kaart, T., & Kärt, O. (2008). Factors affecting the freezing point stability of milk from individual cows. *International Dairy Journal*, 18(2), 210-215.

Ibrahim, N. S., & Jalil, A. R. (2022). The effect of age on milk yield and milk composition in Saanen dairy goats. *Journal of Agricultural Science and Technology A*, 12, 10-14.

IDF (International Dairy Federation) (2002). Milk. Determination of freezing point. Thermistor cryoscope method (reference method). FIL-IDF Standard no. 108:2002/ISO 5764. IDF, Brussels, Belgium.

IDF (International Dairy Federation) (2006). *Milk—Enumeration of somatic cells.* Part 2: Guidance on the operation of fluoro-optoelectronic counters. FIL-IDF Standard no. 148-2 (E). IDF, Brussels, Belgium.

ISO-IDF (International Organization for Standardization and International Dairy Federation) (1989). Milk-Determination of Solids not Fat Content-International Standard ISO 6731:1989 and I.D.F. 021B:1987; ISO: Geneva, Switzerland; Brussels, Belgium.

ISO 21187:2004. Milk – Quantitative determination of bacteriological quality – Guidance for establishing and verifying a conversion relationship between routine method results and anchor method results. Geneva, Switzerland: International Organization for Standardization.

ISO (International Organization for Standardization). 2004b. Milk. Determination of urea content—Enzymatic method using difference in pH (Reference method). ISO 14637:2004. ISO, Geneva, Switzerland.

ISO 13366-1:2008/IDF 148-1:2008, Milk - Enumeration of somatic cells – Part 1: Microscopic method (Reference method), International Organization of

Standardization, Geneva, Switzerland, and International Dairy Federation, Brussels, Belgium.

ISO-IDF (International Organization for Standardization and International Dairy Federation) (2010). Milk-Determination of Fat Content; International Standard ISO 1211 and I.D.F.; ISO: Geneva, Switzerland; Brussels, Belgium.

ISO-IDF (International Organization for Standardization and International Dairy Federation) (2010). Milk-Determination of Lactose Content-Enzymatic Method Using Difference in pH; International Standard ISO 26462:2010 and I.D.F.; ISO: Geneva, Switzerland; Brussels, Belgium.

ISO-IDF (International Organization for Standardization and International Dairy Federation) (2014). Milk and Milk Products-Determination of Nitrogen Content-Part 1: Kjeldahl Principle and Crude Protein Calculation; International Standard ISO 8968-1 and I.D.F.; ISO: Geneva, Switzerland; Brussels, Belgium.

Kędzierska-Matysek, Monika., Litwińczuk, Z., Florek, M., & Barłowska, J. (2011). The effects of breed and other factors on the composition and freezing point of cow's milk in Poland. *International Journal of Dairy Technology*, 64(3), 336-342.

Kondyli, E., Katsiari, M. C., & Voutsinas, L. P. (2007). Variations of vitamin and mineral contents in raw goat milk of the indigenous Greek breed during lactation. *Food chemistry*, 100(1), 226-230.

Kuchtík, J., Šustová, K., Sýkora, V., Kalhotka, L., Pavlata, L., & Konečná, L. (2021). Changes in the somatic cells counts and total bacterial counts in raw goat milk during lactation and their relationships to selected milk traits. *Italian Journal of Animal Science*, 20(1), 911-917.

Li, X. Y., Cheng, M., Li, J., Zhao, X., Qin, Y. S., Chen, D., & Wang, C. F. (2020). Change in the structural and functional properties of goat milk protein due to pH and heat. *Journal of Dairy Science*, 103(2), 1337-1351.

Lindmark-Månsson, H., Bränning, C., Alden, G., & Paulsson, M. (2006). Relationship between somatic cell count, individual leukocyte populations and milk components in bovine udder quarter milk. *International Dairy Journal*, 16(7), 717-727.

Linzell, J. L., & Peaker, M. (1974). Changes in colostrum composition and in the permeability of the mammary epithelium at about the time of parturition in the goat. *The Journal of physiology*, 243(1), 129-151.

Liu, Y., Cai, J., & Zhang, F. (2021). Influence of goat colostrum and mature milk on intestinal microbiota. *Journal of Functional Foods*, 86, 104704.

Mahmut Keskin, Zehra Güler, Sabri Gül & Osman Biçer (2007) Changes in Gross Chemical Compositions of Ewe and Goat Colostrum During Ten Days Postpartum, *Journal of Applied Animal Research*, 32:1, 25-28.

Manser, P. A. (1986). Prevalence, causes and laboratory diagnosis of subclinical mastitis in the goat. *The Veterinary Record*, 118(20), 552-554.

Matei-Lațiu, M. C., Gal, A. F., Rus, V., Buza, V., Martonos, C., Lațiu, C., & Ștefănuț, L. C. (2023). Intestinal Dysbiosis in Rats: Interaction between Amoxicillin and Probiotics, a Histological and Immunohistochemical Evaluation. *Nutrients*, 15(5), 1105.

Morand-Fehr, P., Fedele, V., Decandia, M., & Le Frileux, Y. (2007). Influence of farming and feeding systems on composition and quality of goat and sheep milk. *Small Ruminant Research,* 68(1-2), 20-34.

Noutfia, Y., Zantar, S., Ibnelbachyr, M., Abdelouahab, S., & Ounas, I. (2014). Effect of stage of lactation on the physical and chemical composition of Drâa goat milk. *African Journal of Food, Agriculture, Nutrition and Development*, 14(4), 1981-1991.

Oltner, R., Emanuelson, M., & Wiktorsson, H. (1985). Urea concentrations in milk in relation to milk yield, live weight, lactation number and amount and composition of feed given to dairy cows. *Livestock production science*, 12(1), 47-57.

Peana, I., Fois, G., & Cannas, A. (2007). Effects of heat stress and diet on milk production and feed and energy intake of Sarda ewes. *Italian Journal of Animal Science*, 6(sup1), 577-579.

Poutrel, B., & Lerondelle, C. (1983). Cell content of goat milk: California mastitis test, coulter counter, and fossomatic for predicting half infection. *Journal of Dairy Scienc*e, 66(12), 2575-2579.

Pritchett, L. C., Gay, C. C., Besser, T. E., & Hancock, D. D. (1991). Management and production factors influencing immunoglobulin G1 concentration in colostrum from Holstein cows. *Journal of dairy science*, 74(7), 2336-2341.

Quigley III, J. D., Bernard, J. K., Tyberendt, T. L., & Martin, K. R. (1994). Intake, growth, and selected blood parameters in calves fed calf starter via bucket or bottle. *Journal of dairy science*, 77(1), 354-357.

Saha, S., Pory, F. S., Ahmed, S. S. U., & Mehedi, M. (2022). Physico-Chemical and Microbial Properties of Black Bengal Goat Milk.

Sánchez-Macías, D., Moreno-Indias, I., Castro, N., Morales-delaNuez, A., & Argüello, A. (2014). From goat colostrum to milk: Physical, chemical, and immune evolution from partum to 90 days postpartum. *Journal of Dairy Science*, 97(1), 10-16.

Woodman, H. E. (1921). A comparative investigation of the corresponding proteins of cow and ox serum, cow's colostrum and cow's milk by the method of protein racemisation. *Biochemical Journal*, 15(2), 187.

Zhu, Y., Wang, J., & Wang, C. (2018). Research on the preparation, uniformity and stability of mixed standard substance for rapid detection of goat milk composition. *Animal Science Journal*, 89(5), 794-801.