Boyacá, there were 105.916 animals, accounting for 7.03% of all sheep population in the country.

However, there are not specific data, on number of animals per breed and the organization of the productive chain. Also, this production system is associated to small farmers for self-consumption and local commerce in the cities.

Then, it is necessary not only to improvie productions through better livestock practices but also to improve databases in all the country, for taking productive decisions for the sector. Taking into account not only the meat chain, but also the milk and wool chains, it seems to be an economic alternative for the sheep farmer [21].

To achieve this, it is necessary to use breeds that can adapt easily to the tropical conditions in Colombia, among the breeds that can adapt and move from arid conditions and low rainfall, onto highlands with tropical conditions, like Colombia, is the Dorper breed [6].

There is only one study in Colombia that explored the productive behavior of Dorper breed, compared with White Dorper breed, reporting better daily weight gains, weaned weight and slaughter weight for the Dorper breed [13].

One of the most important factors to make lambs express all genetic and productive potential is the quantity and quality of milk supplied by the mothers, also feeding during the pre-weaning period [11, 12, 18]. The sheep milk quality depends on the breed, udder health, age, parturitions, lactation states, nutritional regime, milking techniques, season and hour of milking [5, 10, 19].

That is the reason to know in all productive system the quality of milk of all ewes across lactation, to ensure lamb development and to decrease mortality rates. Therefore, the objective of this work was to determine the physico-chemical characteristics of sheep raw milk across sixty days in lactation, of the Dorper breed in Boyacá, Colombia.

MATERIAL AND METHODS

Site and type of study. The study was developed in Duitama city (Colombia), situated at 2,600 meters above sea level, with a mean temperature of 14°C [15]. A quantitative descriptive study was performed, with samples taken once in April, ergo in winter.

Animals: 120 animals of Dorper breed, between two and three lactations were included in the study. Three groups were performed, completely randomized, according to days in milk (DIM), group one: between 3 and 20 days; group two: 21 and 40 days, and group three: 41 and 60 days each of them with 40 animals [17]. Animals included in each group were weighed. The average weight for the first group was 50 ± 2.7 kg, for the second group was 55 ± 3.5 kg and for the third group was 62 ± 2.0 kg.

Feeding. The animals shepherded in pastures of Kikuyu (*Cenchrus clandestinum)*, and received *ad libitum,* in the morning, balanced commercial feed, with values of crude protein of 14%, ash 10%, humidity 13%, fat 2.5% and fiber 25%.

Sampling. Only animals with healthy udders were included in this study, for this determination, a clinic exam was performed to all animals to discard udder inflammation, pain, lacerations, and adhesions. *California mastitis test* was used and only ewes that had negative and trace results were included in the study. Before sampling, udders and teats were cleaned using a soap solution, then rinsed with sterile water and dried with sterile gauze, disinfected with iodine solution. Once asepsis was completed, the first milk jet was discarded and the sample was collected in Whirl-pack bags [4]. The samples were taken in the morning before the lambs were reunited with their mothers. Approximately 20 ml were taken of each ewe (10 ml per teat).

Processing. The samples were processed on sampling day in the laboratory of milk quality and mastitis control in the Pedagogical and Technological University of Colombia (Tunja, Boyacá). Percentages of fat, protein, lactose, total solids, non-fatty solids and freezing point expressed in grades centigrades were determined using a milk analyzer based on *Fourier transformed infrared technology* (MilkoScan Mars). Somatic cell count (SCC) was performed with an *Portacheck* equipment for goats.

Statistical analyses. An analysis of variance (ANOVA) was performed between groups of DIM, using the comparison of means of *low significate difference* of Fisher's procedure, with a confidence level of 95%, using software *Statgraphics Centurion*, Windows 10 version.

RESULTS

Table 1 shows the results of means for each physicochemical parameter for each group of DIM, for sheep raw milk of Dorper breed.

The percentage of fat shows an increase between day 21-40, and then it decreases (group 3), but it is still above the percentage of the first group. However, there were no statistically significant differences between the groups. Percentage of total solids described a similar behavior, with no statistical differences between of the groups ($p>0.05$), but in this case, the group 3 had a lower value compared with group 1 (Table 1).

Higher protein percentage was found in the first group, and then it decreased across lactation, with statistically significant differences found between group 1 and the other two groups. Lactose content was high in group two (21-40 DIM), decrease later in group three (41-60 DIM) but still is higher than the group one, and found also a statistically significant differences between three groups.

No differences were found between groups of not fatty solids percentage, however, the values were de-

Table 1. Means values for each physicochemical parameters for each group of days in milk.

parameter	G1 (3-20 d)	G2 (21-40 d)	G3 (41-60 d)	p-value
fat (%)*	7.37 ± 2.33	8.09 ± 0.13	7.54 ± 0.10	>0.05
protein (%)	5.45 ± 0.30a	5.04 ± 0.15b	5.06 ± 0.04b	<0.05
lactose (%)	4.77 ± 0.17c	5.22 ± 0.13a	5.07 ± 0.04b	<0.05
NFS (%)*	11.13 ± 0.43	11.07 ± 0.28	10.98 ± 0.08	>0.05
t.solids (%)*	18.70 ± 2.05	19.17 ± 0.20	18.53 ± 0.15	>0.05
f.point (°C)	-0.5836 ± 0,02a	-0.575 ± 0.004ab	-0.5695 ± 0.016b	<0.05
SCC cells/ml	223.5 ± 19.46a	75.3 ± 13.81b	231.8 ± 17.75a	<0.05

G: group, d: days, *no significant differences, NFS: non fatty solids, SCC: somatic cell counts (x1.000 cells/ml), >menor; <mayor, t: total, f: freezing

scended from group one to group three. In the case of freezing point, exist significant statistically difference between group one and three, but there is not differences between group two and others two groups.

For SCC there is not a significant difference between group one and three, but the group two shows a marked reduction, be this group different statistically of the other two groups.

DISCUSSION

Previous work found improved daily weight gain in Dorper lambs during the first 28 days on lactation [12], which is correlated with milk quality, since this is the principal feed at this stage [8], likewise reported that the capacity of Dorper ewes to produce large quantities of milk, contribute to the high growth potential of the lambs [3].

Moreover, the better quality for raw milk was found in the first and second group. Besides Dorper breed showed a better capacity for maintaining production regimen during gestation and under adverse conditions of feeding, due to maintain better body condition and *greater insulin-like growth factor-1* (IGF-1) concentrations, when it was compared with Rambouliet breed [30].

The studies about Dorper breed raw milk quality are old and scarce around the world. Researchers [8] mentioned that for ewes after 10 days in lactation, the fat content in milk was 7.1%, value that is similar to in the present findings (Table 1), but they found that after 40 DIM the fat percentage was 5.5% on average, which is different with reported here whose value was 8.09% on average. Likewise, they reported that the average value of protein is 5.6%, which is elevated compared with any of groups analyzed here; also, the value of 4.6% for lactose that they reported is lower than shows here.

Previous work reported values of fat in ½ Lacaune x ½ Ile de France ewes of 4.95%, 5.24% and 4.89% when the animals were fed soybean seed-supplemented diet with 0, 70 and 140 g/kg respectively [17], than was lower if we compare with all groups studied here, this due the differences between productive focus of the two breeds, because this crossbred is half dairy and half meat, meanwhile, the Dorper breed is a meat-breed. Results for protein too were lowers than reported here, even for diet with mayor content of soybean seed.

In the same way, others found an average fat percentage for Lacaune and East Friesian breeds (both dairy breeds) of 6.86% and 7.31% respectively [27], which are lower for values reported here for Dorper breed in three groups. Lacaune´s protein percentage was 4.93%, but for East Friesian this percentage was 5.18%, the first of them is lower for any groups analyzed here, but the second result is higher than groups 2 and 3.

Others performed a study for the determination of the variations that exist between raw milk of Santa Ines ewes [7] (meat breed), undergoing treatment of oxytocin, obtaining an average for percentage of fat of 4.96% for untreated ewes, and 5.84% for treated ewes, which are lower than reported here, due possibly to breed difference and feed regimen. However, the results for not fatty solids were 11.22% for the untreated group and 11.57% for the treated group, values that are higher than reported here for any group studied, due possibly to an increase of other milk constituents.

Scientifics found statistical variations in properties of raw milk of breed Latxa sheep through winter spring and summer in the Basque country [2], for April (winter), the fat percentage were 6.10% and protein were 4.89%, which were lower than reported here, due to distinct climatic, feeding and breeds conditions.

The peak of production is related to the lactose content for Santa Ines ewes, reported the major level of production at 37 DIM [7]. This is correlated with found here for lactose content which was higher in group two (21-40 DIM); also, the results of this study are similar to reported by others [29], who correlated the percentage of lactose and production peak, and found that this occurred in the third week (21 DIM) for Talaverana breed.

Generally in sheep, high content of lactose is associated with low fat and protein values, due to the dilution factors [23]; similar process were found here, where group G2 (highest lactose content) has the lowest percentage of protein compared to G1, but not occur the same for fat percentage.

The *"Guide of udder health for dairy sheep"* stated that a result between 0-200.000 cells/ml are negative results, and 150.000-500.000 cells/ml are trace results, due to apocrine secretion with a cytoplasmic particles normal in milk [20].

The present study shows that group one and three had trace results, and group two has negative results. It has been mentioned [16] that mastitis, even this is subclinical cause loss of milk yield and modification of main components, as a result of damage in the mammary secretory tissue. It has been mentioned [26] that percentage of protein is reduced when the SCC increase above 500.000 cells, while for fat percentage this is reduced when SCC increase above 2.000.000 cells/ml.

SCC varied across lactation in our study. Our values are higher than those reported by others [17] for ½ Lacaune x ½ Ile de France whose results were between 145.750 and 203.000 cells/ml. But our results were lowered than reports of others [2], whose ranked were between 263.000 and 467.000 cells/ml.

Some publications [21] refer that mean freezing point for Lacaune´s milk in Brazil was -0.577 (°C) and were similar to results of group 2, but different for the others two groups. This trait is related with the percentage of total solids that have the milk, and in dairy industries is very important because it can function like an indicator of milk quality through the determination of water addition.

Is well known that climatic conditions can affect milk quality and quantity [25], likewise feeding regimen and quality of feed, numbers of lambs per birth and sex of lambs (males or females) [1, 22, 28, 30].

Statistical differences found between the three groups for percentage of protein and lactose, freezing point and somatic cell counts. There were not statistical differences between fat, total solids and not fatty solids. Physicochemical characteristic of Dorper raw milk were better than others breeds even dairy or meat breeds. The information related with this topic in Colombia is the first, and was updated in the world.

REFERENCES

1. **Abecia JA, Palacios C**. 2017. Ewes giving birth to female lambs produce more milk than ewes giving birth to male lambs. *Ital J Anim Sci* 17: 736-739.
2. **Abilleira E** *et al.* 2010. Effects of seasonal changes in feeding management under part-time grazing on the evolution on the composition and coagulation properties of raw milk from ewes. *J Dairy Sci* 93: 3902-3909.
3. **Alemseged Y, Hacker R**. 2014. Introduction of Dorper sheep into Australian rangelands: implications for production and natural resource management. *The Rang Jour* 36: 85-90.
4. **Andrade J, Pulido M, Rodríguez C.** 2012. Métodos de muestreo. In: *Sanidad de Ubre, Calidad de Leche,* Ed. UPIC, Bogotá, Colombia, 170 p.
5. **Brito MA** *et al.* 2006. Composição do sangue e do leite em ovinos leiteiros do sul do Brasil: variações na gestação e na lactação. *Ciência Rural* 36: 942-948.
6. **Budai C** *et al.* 2013. Performance and adaptability of the Dorper sheep breed under hungarian and romanian rearing conditions. *Anim Sci and Biotech* 46: 344-349.
7. **Carvalho R** *et al.* 2007. Produção, composição e rendimento em queijo do leite de ovelhas Santa Inês tratadas com ocitocina. *R Bras Zootec* 36: 438-444.
8. **Cloete SW, Snyman MA, Herselman MJ**. 2000. Productive performance of Dorper sheep. *Small Rum Res* 36: 119-135.
9. **Colby L.** 2015. Current situation. In: World sheep meat market to 2025. *AHDB Beef & Lamb Press,* p. 8.
10. **Deolives AM, Díaz JR, Molina MP, Perist C**. 2013. Quantification of milk yield composition changes as affected by subclinical mastitis during the current lactation in sheep. *J Dairy Sci* 96: 7698-7708.
11. **Ferreira EM** *et al.* 2018. Milk yield and composition from ewes fed raw soybeans and their lamb´s performance. *Anim Feed Sci & Tech* 238: 1-8.
12. **Gavojdian D, Czister LT, Pacala N, Sauer M**. 2013. Productive and reproductive performance of Dorper and its crossbreds under a Romanian semi-intensive management system. *S Afr J Anim Sci* 43: 219-228.
13. **Hernández JL.** 2017. Comparación de ganancia de peso, longitud y altura a la cruz: en raza ovina Dorper y Dorper White bajo condiciones de trópico colombiano. *Bachelor Thesis, Universidad de La Salle,* Bogotá (Colombia).
14. **Instituto Colombiano Agropecuario ICA**. 2018. Censo Pecuario Nacional: *https://www.ica.gov.co/areas/pecuaria/servicios/epidemiologia-veterinaria/censo s-2016/censo-2018*, aspx, Bogotá, Colombia..
15. **Instituto de hidrología, meteorología y estudios ambientales, IDEAM**. 2019. *http://institucional.ideam.gov.co/jsp/mapas-y-graficos-del-tiempo-y-el-clima_882.* Información climática nacional. Bogotá, Colombia.
16. **Leitner G** *et al.* 2004. Changes in milk composition as affected by subclinical mastitis in sheep. *J Dairy Sci* 87: 46-52.
17. **Lopes NM** *et al.* 2015. Production, composition and processing of milk from ewes fed soybeans seeds. *R Bras Zootec* 44: 146-154.
18. **Macmanus CM** *et al.* 2014. Effect of supplementary milk feeding on growth and survival of Santa Ines lambs. *Ciênc Anim Bras Goiânia* 15: 452-457.
19. **Malissiova E** *et al.* 2015. Relationship between production conditions and milk gross composition in ewe's and goat's organic and conventional farms in central Greece. *Dairy Sci & Technol* 95: 437-450.
20. **Menzies P** *et al.* 2013. Mastitis. What causes it and how it is detected. In: *A guide to udder health for dairy sheep* (University of Guelph press, Ontario), p. 3-4.
21. **Merlin IA** *et al.* 2015. Sheep milk: physical-chemical characteristics and microbiological quality. *Arch Latin Nutr* 65: 193-198.
22. **Mikolayunas C, Armentano LE, Thomas DL, Berger YM.** 2009. Effect of protein degradability on milk production of dairy ewes. *J Dairy Sci* 92: 4507-4513.
23. **Nudda A, Bencini R, Mijatovic S, Pulina G.** 2002. The yield and milk composition of milk in Sarda, Awassi, and Merino sheep milked unilaterally at different frequencies. *J Dairy Sci* 85: 2879-2884.
24. **Organization for Economic Cooperation and Development (OECD).** *Food and Agricultural Organization of the United Nations (FAO).* 2018. *Meat. in Agricultural Outlook* 2018-2027, M.I. *OECD Publishers*, p. 150-162.
25. **Ramón M, Díaz C, Pérez MD, Carabaño MJ.** 2016. Effect of exposure to adverse climatic conditions on production in Manchega dairy sheep. *J Dairy Sci* 99: 5764-5779.
26. **Sutera A** *et al.* 2018. Determination of milk production losses and variations of fat and protein percentages according to different levels of somatic cell count in Valle de Belice dairy sheep. *Small Rum Res* 162: 39-42.

27. **Ticiani E, Sandri EC, Sousa J, Batistel F, Oliveira DE.** 2013. Persistência da lactação e composição do leite em ovelhas leiteiras das raças Lacaune e East Friesian. *Ciência Rural* 43: 1650-1653.
28. **Valdivielso I, Renobales M, Aldai N, Barron LE**. 2017. Changes in terpenoid composition in milk and cheese from commercial sheep flocks associated with seasonal feeding regimen throughout lactation. *J Dairy Sci* 100: 96-105.
29. **Velasco S, González J.** 2001. Producción lechera y composición lipídica de la leche de ovejas Talaveranas durante el período de lactancia. *Inv Agr Prod San Anim* 16: 182-192.
30. **Whitney TR, Waldron DF, Willingham TD.** 2009. Evaluating nutritional status of Dorper and Rambouillet ewes in range sheep production. *Sheep & Goat Res J* 24: 10-16.