https://doi.org/10.22319/rmcp.v12i2.5519

Technical note

Characterization of the lactation curve and milk quality in Santa Cruz sheep (*Ovis aries*)

Ingrid Merchant [a]

Agustín Orihuela [a]*

Reyes Vázquez [a]

Virginio Aguirre [a]

[a] Universidad Autónoma del Estado de Morelos. Facultad de Ciencias Agropecuarias. Avenida Universidad 1001 Colonia Chamilpa, Cuernavaca Morelos 62210, México.

* Corresponding author: aorihuela@uaem.mx

Abstract:

Milk production and quality during lactation in hair sheep is vital to lamb survival and maintenance. Despite their importance, little data is currently available on these characteristics. An experiment was done to characterize the lactation curve and milk quality in ewes of the Santa Cruz hair sheep breed. Animals were 18 multiparous ewes that had lambed within four days. Milk production was recorded every 72 h from 6 to 60 d postpartum (dpp), and milk quality was quantified once a week from a sample of the day's total production. Milk production was 1.95 L at 6 dpp, 2.31 L at 12 dpp and 1.01 at 57 dpp. Total solids were 18% at week two and increased to 20.5 % at week eight. Milkfat was 8% at week two and increased to 9.8 % at week eight. The protein (4.86 to 5.18 %) and lactose (4.68 to 4.74 %) percentages remained relatively uniform throughout lactation. Milk production in Santa Cruz ewes is highest in the second week of lactation and then decreases steadily and gradually. Milk total solids and fat percentages increased over time, while protein and lactose percentages remained constant.

Key words: Protein, Lactose, Fat, Total solids, Milk production, Sheep**.**

Received: 26/09/2019

Accepted: 23/07/2020

Sheep farming in the tropics is mainly focused on meat production. Hair breeds are widely used due to their adaptability to high temperatures, resistance to parasites and high prolificacy[1]. Extensive systems are the most common production system in the tropics. Lamb production is the highest value product of these systems and represents the main income source for producers[2].

Milk production in hair breeds is fundamental to lamb survival, growth and weaning weight[3,4], with any surplus used in human foods. Despite its importance, information on milk production and quality in hair sheep during lactation is limited to a few studies in breeds such as Santa Cruz, Blackbelly, and Katahdin[5-7], as well as some West African breeds[8]. Sheep milk nutritional composition has only been characterized in Blackbelly x Katahdin sheep[9,10]. This lack of research is puzzling since sheep milk is popular among human consumers in tropical North and Central America[11,12].

Daily milk intake is the most important factor influencing lamb growth rates. Offspring survival, growth potential and weaning weight therefore depend on milk production during the mother's lactation[3,4]. Genotypes vary widely between tropical sheep breeds. This means that estimation of milk production during lactation, as well as variation in milk composition, are essential data for establishing sheep and lamb management strategies for specific breeds. The present study objective was to characterize milk production and quality in Santa Cruz ewes, from parturition to weaning.

The study was carried out at the Faculty of Agricultural Sciences, Autonomous University of the State of Morelos (Universidad Autónoma del Estado de Morelos). The experimental field is located at 18°56' N and 99°13' W, at an altitude of 2,160 m asl. Average annual temperature in the region is 20 °C, and average annual rainfall is 1,243 mm.

The experimental animals were eighteen multiparous Santa Cruz ewes with a 2.0 years' average age and 51.22 ± 2.36 kg weight. All had lambed within four 4 d of the beginning of the experiment. Of the ewes included in the study, 12 gave birth to twins, 2 had triple births and 4 single births. During gestation, the ewes were kept in a single group, grazing from 0800

to 1400 h in a pasture with African star grass (*Cynodon nlemfluensis*). During the remaining hours they were penned and provided a supplement of 300 g commercial concentrate. This concentrate contributed 16 % crude protein (CP) and 2.79 Mcal/kg metabolizable energy (ME), while the forage (alfalfa + sorghum) provided 7.6 % CP and 1.78 Mcal/kg ME. The diet consisted of 50 % concentrate and 50 % forage, meaning it covered the nutritional requirements of a 60 kg sheep, with two young, producing between 0.79 and 1.48 kg milk per day[13].

During lactation, the ewes were given free access to a forage mixture (30 % alfalfa and 70 % sorghum straw), 1 kg of the same commercial concentrate feed, and water. For the first 5 days postpartum (dpp) each ewe was housed with her offspring in individual 2 x 2 m roofed pens with a cement floor, individual feeder and drinker. From 6 dpp to weaning (60 dpp) all ewes and their lambs were kept in a single group inside a roofed pen (4 m^2/ewe), with concrete floor, a trough and a shared drinker. Beginning at 14 dpp, the pen was equipped with a creep feeder to provide the lambs free access to an 18 % CP commercial concentrate.

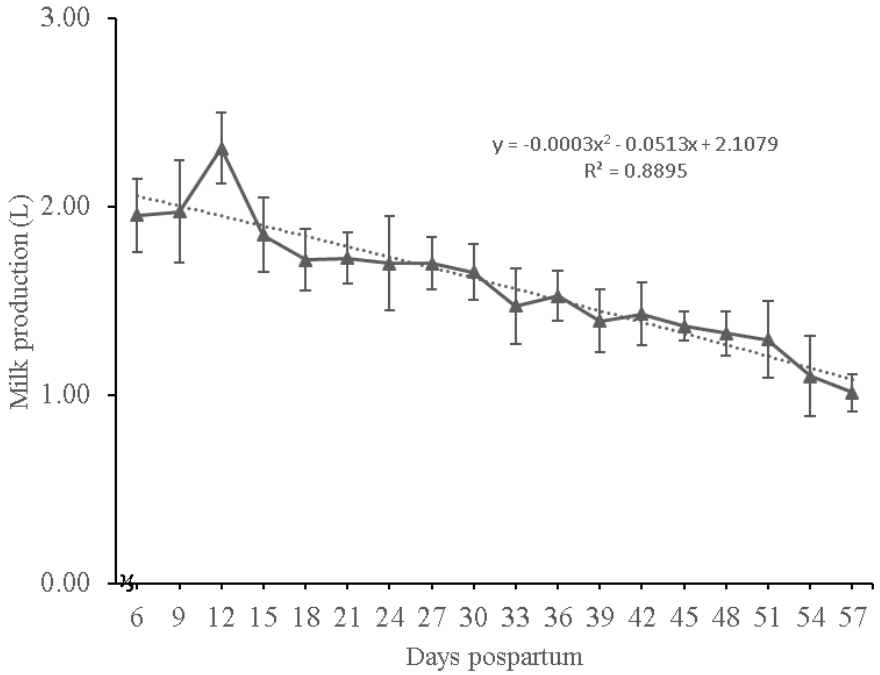
Starting at 6 dpp, ewe milk production was measured every three days using the "oxytocin method". This consists of separating the lambs from the ewes, intravenously administering 5 IU synthetic oxytocin (Oxitopisa; Pisa; Hidalgo, México), and completely milking the udder manually. Four hours after the first hormone application, a second dose is applied, the udder milked again, and milk volume recorded. This value is multiplied by six to estimate daily production[14].

Milk quality was measured once a week using a 50 mL milk sample collected from the daily milk production. Milk protein, fat, lactose, and total solids contents were quantified using an infrared spectrophotometry method[15] applied by an outside laboratory (Alimenlab; Jalisco, Mexico).

Statistical analysis of milk production and quality was done by applying a polynomial regression to produce the equation, the R^2 value and its probability. All analyses were run using the PROC REG procedure[16].

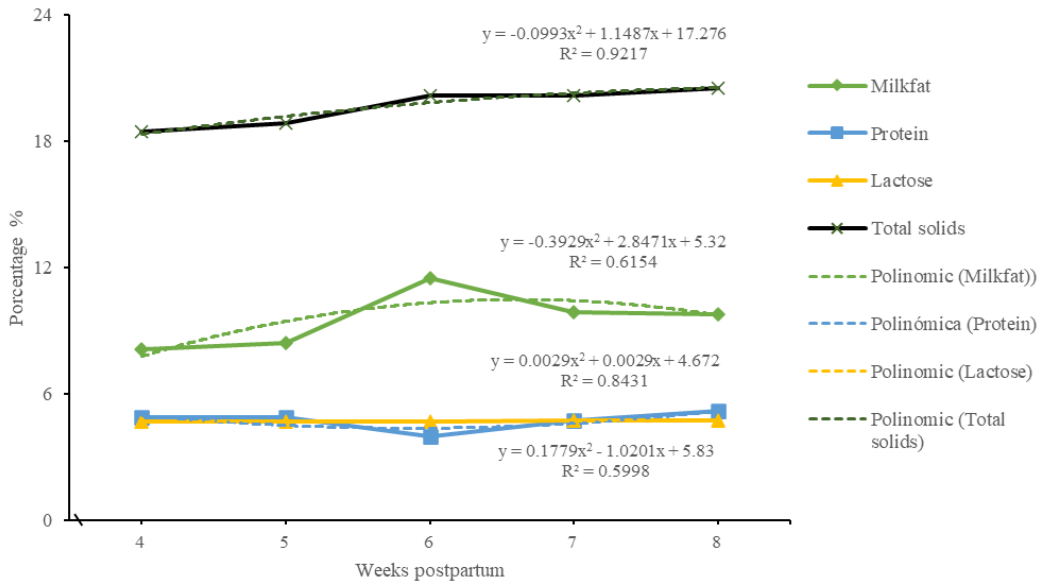
Milk production at 6 dpp was 1.95 L, increased to a maximum of 2.31 L at 12 dpp, and decreased to 1.01 L at 57 dpp. The lactation curve was divided into five periods of 9 d each. Production during the first two periods (equivalent to 18 dpp) did not differ (P>0.05). However, when compared to the first two periods, production began to gradually decrease (P<0.05) thereafter; 15 % in the 3rd period (27 dpp), 26 % in the 4th (36 dpp) and 39 % in the 5th (45 dpp). Average ewe weight did not differ during lactation (P>0.05): 52.24 ± 1.19 kg at parturition and 52.00 ± 1.63 kg at weaning. The corresponding regression analysis (Figure 1) identified an inversely proportional relationship over time, adjusted to a polynomial trend line: r^2= 0.88; y= -0.0003x^2-0.0513x+2.1079 (P= 0.0001).

Figure 1: Lactation curve for Santa Cruz ewes during 60 days postpartum (mean ± SE) (P≤0.001). Polynomic regression



Total solids percentage began at 18 % in week two of lactation and increased to 20.5 % by week eight (Figure 2). The corresponding regression analysis showed a proportional relationship over time: r^2=0.92; y=- 0.0993x^2+1.1487x+17.276 (P=0.01).

Figure 2: Composition of milk from Santa Cruz breed ewes during first 60 days postpartum (mean ± SE) ($P \leq 0.001$)



Milkfat increased from 8 % in week two of lactation to 9.8 % at the end of lactation (week eight). The regression analysis confirmed this trend: $r^2 = 0.61$; $y = -0.3929x^2 + 2.8471x + 5.32$ ($P = 0.23$). The protein percentage increased from 4.86 % in week two to 5.18 % at the end of lactation while the lactose percentage increased from 4.68 to 4.75 %. The regression analysis identified minimal fluctuation throughout lactation for both variables: protein, $r^2 = 0.84$, $y = 0.0029x^2+0.0029x+4.672$ ($P=0.90$); lactose, $r^2 = 0.60$; $y = 0.1779x^2–1.0201x+5.83$ ($P = 0.05$).

Milk production in the evaluated ewes was highest at 12 dpp, without a clear peak, and then decreased gradually and constantly. Maximum milk secretion in different sheep breeds is generally reported between the second and fourth weeks of lactation[17]. The maximum production at 12 d observed in the present study coincides with previous reports for Katahdin sheep[7], Ile de France sheep[18] and other breeds[19]. However, the quantity of milk produced during this same period was higher in Santa Cruz (2.33 L/d) than in the aforementioned meat breeds (Katahdin =1.38, Ile de France = 0.50 and Others = 0.43 L/d). This highlights the relatively higher milk production in hair breeds[20] when compared to meat breeds of European origin. The lack of a clear peak in milk production in Santa Cruz ewes has been reported elsewhere[7]. This may be due to high dietary energy content[21-23]; in the present study and the previous one[7], the same feed concentrate was offered, although the forage was different (alfalfa + sorghum straw vs. corn silage), and feed was freely available.

In milk composition, the total solids and fat percentages were higher at the end of lactation. This is generally to be expected since as milk production decreases, total solids and fat become more concentrated. This is reported in other breeds[24], including specialized milk production breeds[25-26]. Higher total solids and fat contents are associated with lower quality milk[27].

Of note in the present results is that the protein and lactose percentages remained constant throughout lactation. Given the total decrease in milk production as lactation progresses, this suggests an increase in these substances over time. This could be an important advantage in the nutritional characteristics of milk from Santa Cruz ewes, but further research is needed to confirm this finding.

Higher protein and lactose concentration in milk may be a response to the fact that tropical sheep live under humid conditions, reducing the need for lambs to receive water via mother's milk. An inverse situation has been reported in other species inhabiting desert climates, in which milk water content increases[27]. Tropical breeds are also lighter in weight than European breeds, suggesting that their lower maintenance requirements could allow for greater nutrient allocation and consequently better milk quality[19].

In conclusion, milk production in Santa Cruz sheep reaches a maximum around the second week of lactation and then decreases constantly and gradually. As a result, the percentages of total solids and fat increase over time, while those of protein and lactose remain constant.

Conflict of interests

The authors declare no conflict of interest in the present study.

Acknowledgements

The research reported here forms part of doctoral research by Ingrid Merchant Fuentes who received a scholarship from the CONACyT (No. 410994).

Literature cited:

1. Quintanilla-Medina JJ, González-Reyna A, Hernández-Meléndez J, Limas-Martínez AG, Carreón-Pérez A, Martínez-González JC. Producción de ovinos de pelo bajo condiciones de pastoreo en el noreste de México. Rev Invest Vet Peru 2018;(29):544–551.

2. FAOSTAT. Estadísticas | FAO | Organización de las Naciones Unidas para la Alimentación y la Agricultura. División de las Estadísticas de la Organización de las Naciones Unidas para la Alimentación (FAO). 2013.

3. Banchero GE, Quintans G, Milton JT, Lindsay DR. Alimentación estratégica para mejorar la lactogénesis de la oveja al parto. Seminario de actualización técnica: Reproducción Ovina. INIA 2005;(33 Tacuarembó):127–136.

4. Millanao I, Herdener N, Parada D, Sepúlveda N. Producción de leche , curvas de lactancia y crecimiento de sus corderos, en dos razas de ovejas en la región de la Araucanía Chile. Sitio Argentino Prod Anim 2007;(APPA-ALPA):1–4.

5. Godfrey RW, Gray ML, Collins JR. Lamb growth and milk production of hair and wool sheep in a semi-arid tropical environment. Small Ruminant Res 1997;(24):77–83.

6. Peniche-Gonzalez I, Sarmiento-Franco L, Santos-Ricalde R. Estimation of milk production in hair ewes by two methods of measurement. Rev MVZ Córdoba 2015;(20):4629–4635.

7. Burgos-González C, Huerta-Aparicio M, Aguirre V, Vazquez R, Orihuela A, Pedernera M. Short communication : Milk production and lamb development in Saint Croix and Katahdin hair sheep breeds (*Ovis aries*). Trop Anim Health Prod 2017;(3):683-687.

8. Ünal N, Akçapinar H, Atasoy F, Yakan A, Uğurlu M. Milk yield and milking traits measured with different methods in Bafra sheep. Rev Med Vet (Toulouse). 2008;(159):494–501.

9. Araujo RC, Pires AV., Susin I, Mendes CQ, Rodrigues GH, Packer IU, et al. Milk yield, milk composition, eating behavior, and lamb performance of ewes fed diets containing soybean hulls replacing coastcross (*Cynodon* species). J Anim Sci 2008;(86):3511–3521.

10. Peniche-Gonzalez I, Sarmiento-Franco LA, Santos-Ricalde RH. Utilization of Mucuna pruriens whole pods to feed lactating hair ewes. Trop Anim Health Prod 2018;(7):1455-1461.

11. Notter DR. Effects of ewe age and season of lambing on prolificacy in US Targhee, Suffolk, and Polypay sheep. Small Ruminant Res 2000;(38):1–7.

12. Sánchez-Dávila F, Bernal H, Colín J, Olivares E, del Bosque AS, Ledezma R, *et al*. Environmental factors and interval from the introduction of rams to estrus in postpartum Saint Croix sheep. Trop Anim Health Prod 2011;(43):887–891.

13. Nutrient requirements of small ruminants; Sheep, goats, cervids, and new world camelids. Animal Nutrition Series, National Research Council of the National Academies. 2007.

14. Velasco S, Cañeque V, Díaz MT, Pérez C, Lauzurica S, Huidobro F. Producción lechera y composición lipídica de la leche de ovejas Talaveranas durante el período de lactancia. Investig Agrar Prod y Sanid Anim 2001;(16):182–192.

15. ISO. Determination of milkfat, protein and lactose content. 1999.

16. SAS. Proceedings of the Twenty Eighth Annual SAS Users Group International Conference. SAS Instit. Cary, NC; 2003.

17. Church D. Alimentos y alimentación del ganado. 2da ed. Montevideo, Uruguay; 1989.

18. Lopes-Zeola BNM, da Silva-Sobrinho GA, Hatsumura CT, Borghi TH, Viegas CR, Barbosa JC. Production, composition and processing of milk from ewes fed soybean seeds. Rev Bras Zootec 2015;(44):146–154.

19. De Souza-Emediato RM, Ramos-De Siqueira E, De Melo-Stradiotto M, Maestá SA, Gonçalves HC. Desempenho de ovelhas da raça Bergamácia alimentadas com dieta contendo gordura protegida. Rev Bras Zootec 2009;(38):1812–1818.

20. Forcada F, Thos J, Lopez M, Sierra I. Producción de leche de la raza Rasa Aragonesa en la fase de amamantamiento del cordero. Actas IX Jornadas SEOC 1984:161–164.

21. Resksupaphon J. Nutritional effects on mammary development and milk production: effects of prepartum protein supplements [Master thesis]. Universiy of New England; 1996.

22. Ripoll-Bosch R, Álvarez-Rodríguez J, Blasco I, Picazo R, Joy M. Producción de leche y crecimiento de corderos en la raza Ojinegra de Teruel. Inf Téc Económ Agrar 2012;(108):298–311.

23. Manterola H, Cerda D, Mira J, Pavlic A. Producción y composición de la leche en ovejas Merino precoz, Suffolk y Suffolk x Merino. Adv Prod Anim 2007;(32):59–70.

24. Pulina G, Nudda A. La produzione del latte. In: Pulina G, editor. L'alimentazione degli ovini da latte. Avenue Media, Bologna, Italy; 2001:9-31.

25. Bencini R, Pulina G. The quality of sheep milk: a review. Aust J Exp Agric 1997;(37):485–504.

26. Pulina G, Macciotta N, Nudda A. Milk composition and feeding in the Italian dairy sheep. Ital J Anim Sci 2005;(4 Suppl. 1):5–14.

27. Hinde K, Milligan LA. Primate milk: Proximate mechanisms and ultimate perspectives. Evol Anthropol 2011;(20):9–23.