

Relationships of conformation traits with somatic cell score in Nubian goats

César Andrés Ángel-Sahagún¹ , Sonia Betzabeth Campos-Castillo² ,
Abner Josué Gutiérrez-Chávez¹ , Alma Arianna Lechuga-Arana³ , José
Antonio Hernández-Marín¹ , Lisa Shepard⁴ , Hugo H. Montaldo⁵ ,
Mauricio Valencia-Posadas^{1*} 

¹ Universidad de Guanajuato, División de Ciencias de la Vida, campus Irapuato-Salamanca, Departamento de Veterinaria y Zootecnia, Irapuato, Guanajuato, México.

² Universidad de Guanajuato, División de Ciencias de la Vida, campus Irapuato-Salamanca, Programa de Medicina Veterinaria y Zootecnia, Irapuato, Guanajuato, México.

³ Universidad de Guanajuato, División de Ciencias de la Vida, campus Irapuato-Salamanca, Programa de Doctorado en Biociencias, Irapuato, Guanajuato, México.

⁴ American Dairy Goat Association, Spindale, NC, USA.

⁵ Universidad Nacional Autónoma de México, Facultad de Medicina Veterinaria y Zootecnia, Departamento de Genética y Bioestadística, Ciudad de México, México.

*Corresponding author:
posadas@ugto.mx

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ABSTRACT - Records of 3716 Nubian goats from the United States (US) were analyzed to estimate relationships between fourteen conformation traits (CT) with lactation average somatic cell score (ASCS). To analyze ASCS, a mixed model was implemented. Linear and quadratic effects of CT traits, days in milk (DIM), and kidding age in months (KA) were considered as fixed covariates, and herd-year (HY) of kidding as a random effect. Correlation coefficients between CT traits and ASCS adjusted for HY and linear and quadratic KA effects were also obtained. The average \pm standard deviations for ASCS, DIM, and milk yield were $5.17 \pm 0.54 \text{ Log}_2$, equivalent to $451.3 \text{ cells} \times 10^3/\text{mL}$, 266.3 ± 52.1 days, and 776.3 ± 280.4 kg per lactation, respectively. Significant non-linear relationships with an intermediate maximum were found between ASCS with teat diameter and medial suspensory ligament, while linear relationships were observed with stature, strength, rump width, fore udder attachment, udder depth, teat diameter, teat placement, and medial suspensory ligament. The model explained 53.7% of the ASCS variability, but the contribution of each type variable to increase the coefficient of determination was low ($<0.52\%$). Herd-year explained a large proportion of the variation of ASCS (38.4%). All estimated correlations between CT and ASCS had low values, from -0.04 to 0.11 , but most were significant. The results of this study show that conformation traits have few opportunities to contribute phenotypically to assess somatic cell score in Nubian goats.

Keywords: dairy goats, type traits, udder health

1. Introduction

In dairy goat populations from countries such as France, the United States of America (US), and Spain, several traits have been included in the selection programs aiming at increasing the economic efficiency of goat production in commercial dairy herds (Rupp et al., 2011). These include milk, fat, and protein production (Wiggins and Hubbard, 2001), as well functional traits, such as

reproduction, health, and conformation traits (Torres-Vázquez et al., 2009; Montaldo et al., 2010; Castañeda-Bustos et al., 2014).

The linear appraisal system of the US American Dairy Goat Association (ADGA) was developed to evaluate individual conformation traits (CT) that may affect the structural and functional durability of animals (ADGA, 2014). A good conformation, or type, is considered as having a direct relationship with productivity, longevity, and resistance to diseases in dairy goats (ADGA, 2012). Some CT traits are related to longevity in dairy goats. Castañeda-Bustos et al. (2017) found genetic correlations between functional productive life at 72 months of age (FPL72) with final score, fore udder attachment, and udder depth of 0.52, 0.37, and 0.36, respectively, and authors concluded that when selecting these traits it is possible to increase FPL72 in goats. In the same study, they found nonlinear relationships between many type traits and productive life as well.

Udder CT is associated with somatic cell score (SCS) in dairy cattle (VanRaden, 2018), and the somatic cell count (SCC) has been used for many years to determine the health status of the mammary gland as it is an indirect indicator of intramammary infection, which is associated with subclinical mastitis (Haenlein, 2002). High levels of SCC are related to undesirable changes in composition (Zeng and Escobar, 1995) and milk production losses of up to 29% per day (Barrón-Bravo et al., 2013). Jimenez-Granado et al. (2014) mentioned that, without intramammary infection, the increase of SCC may be due to extrinsic factors to the animal, such as inadequate pens and facilities or incorrect management of milking, and intrinsic factors, such as age or number of lactation of the goat, stage of lactation, and duration and frequency of milking, among others.

In some studies, test-day SCC are transformed to SCS by a classical logarithmic transformation (Wiggans and Shook, 1987; Apodaca-Sarabia et al., 2009; Rupp et al., 2011; Scholtens et al., 2020) to achieve normality of distribution; therefore, their use could be an effective strategy when using linear models for data analysis.

On the other hand, Nubian is the single most popular dairy goat breed within the USA, where there is the International Nubian Breeders Association, outnumbering all other registered breeds (USDA, 2002). Nubian goats have been selected for milk production and fat content for decades (ADGA, 2018; INBA, 2018). Some goat breeders in coordination with ADGA routinely classify their goats by conformation using the linear appraisal system and carry out the dairy recording system of their animals, which includes milk production and SCC, following ADGA procedures and policies.

Few studies exist evaluating the relation between conformation traits and SCC or related traits in dairy goats (Montaldo and Martínez-Lozano, 1993; Rupp et al., 2011). However, no more scientific information was found about relationships between conformation traits and SCC in dairy goats. In addition, further research is needed because there may be nonlinear relationships between conformation traits and somatic cells. For farmers, technicians, and all those associated with goat production, it is important to generate new information related to the association of CT with SCS.

The aim of this study was to evaluate linear and non-linear phenotypic relationships between conformation traits with SCS in US Nubian goats.

2. Material and Methods

This study used 3716 records of Nubian goats from 1989 to 2010 from 195 herds registered by the ADGA in the US, processed by the Laboratory of Animal Improvement Programs of the Agricultural Research Service of the Department of Agriculture of the United States of America, which certifies milk production records and genetic evaluations. Animals were classified for the following fourteen conformation traits: stature (STA), strength (STR), dairyness (DAI), rump angle (RAN), rump width (RUW), rear legs (REL), fore udder attachment (FUA), rear udder height (RUH), rear udder arch (RUA), medial suspensory ligament (MSL), udder depth (UDE), teat placement (TEP), teat diameter (TDI), and

final score (FIS), using the ADGA linear appraisal system. A scale of 50 to 99 points was used for FIS, while for all other type traits, a scale of 1 to 50 points was used (ADGA, 2014), and all of them were previously corrected for age at appraisal (Luo et al., 1997).

Individual data on milk yield were obtained monthly during the lactation, and milk analysis included SCC using flow-cytometry Somacount laser equipment calibrated with cow milk. For SCC, each goat record was considered to include at least five and as many as ten monthly determinations during lactation. To have a variable close to a normal distribution, SCC was transformed to a linear scale from 0 to 9 based on a transformed variable defined as SCS. The formula used for the transformation was $SCS = \text{Log}_2(\text{SCC}/100,000) + 3$ (Wiggans and Shook, 1987). All data used in this study, including the somatic cell determinations, lactation variables, and the conformation qualification of the goats, were collected during the same lactation.

We edited the original data file and excluded incomplete records, values outside the normal range, animals that were less than 10 months old at first kidding, and animals whose parents were not Nubian. An average somatic cell score (ASCS) was obtained for each goat from test-day determinations of SCC during the complete lactation.

Because kidding years from 1989 to 1995, 1996, 1997, and 2007 to 2010 had a reduced amount of data, they were regrouped by adding records of adjacent years, and finally 12 levels were generated. A combination of herd-year (HY) effects was subsequently performed, which is often considered fixed, but research shows statistical advantages when used as random rather than fixed, especially when the number of observations per level is small (Schaeffer, 2009).

For data analysis, we evaluated a full mixed model, which in matrix notation is:

$$y = Xb + Zu + e,$$

in which y is the response variable (ASCS) vector; X is the incidence matrix of fixed effects including SK, LN, and MP, linear and quadratic effects of STA, STR, DAI, RAN, RUW, FUA, RUH, RUA, REL, UDE, TDI, TEP, MSL, and FIS, and KA and DIM as covariates; b is the solution vector for fixed effects; Z is the incidence matrix of the random effect HY; u is the solution vector for HY random effect; and e is the random error term.

Only those variables that were significant ($P < 0.05$) were retained in the final model. Correlation coefficients between CT traits adjusted for HY effects and ASCS adjusted for HY and linear and quadratic KA effects were also obtained. All statistical analyses were conducted with the Statistical Analysis System program (SAS, 2015). Descriptive statistics of the studied traits were also obtained.

3. Results

Table 1 includes descriptive statistics for ASCS, milk production, kidding age, and conformation traits. The average \pm standard deviation for ASCS was $5.17 \pm 0.54 \text{ Log}_2$, equivalent to $451.3 \text{ cells} \times 10^3/\text{mL}$, for the complete lactation with a coefficient of variation (CV) of 10.4%. Unadjusted mean and standard deviation for milk yield was $776.3 \pm 280.4 \text{ kg}$. Traits with the highest CV were KE, MP, TEP, TDI, and STA with 55.0, 36.1, 29.7, 28.7, and 23.7%, respectively. The highest type trait scores were for FIS, UDE, FUA, and RUH, with values of 86.3, 34.6, 33.7, and 33.3 points, and the lowest were for TEP, RUH, and STA (1, 1, and 2 points), respectively.

Non-linear relationships showing an intermediate maximum value were found between ASCS with TDI and MSL ($P < 0.05$), and linear relationships were observed between ASCS with STA, STR, RUW, FUA, UDE, TDI, TEP, and MSL ($P < 0.01$; Table 2). The model explained 53.7% of the ASCS variability, but the contribution of each type variable to increase the R^2 was low ($< 0.52\%$). Herd-year explained a large proportion of the variation of ASCS (38.4%). All estimated correlations between CT and ASCS had low values, from -0.04 to 0.11 , but most were significant ($P < 0.01$).

Table 1 - Descriptive statistics for the average somatic cell score (ASCS) and studied traits in Nubian goats of the United States (n = 3716)

Trait	Unit	Average	Min	Max	SD	CV (%)
ASCS	Log ₂	5.17	2.08	6.22	0.54	10.4
MP	kg	777.3	136.1	1235.2	280.4	36.1
KA	Months	35.4	10	142	19.5	55.1
STA	Points	26.9	2	50	6.4	23.7
STR	Points	28.2	10	45	3.8	13.6
DAI	Points	32.4	14	43	3.2	9.9
RAN	Points	30.7	5	45	4.4	14.4
RUW	Points	28.1	4	44	4.1	14.5
FUA	Points	33.7	6	48	3.8	11.2
RUH	Points	33.3	1	47	5.2	15.6
RUA	Points	25.9	5	48	5.5	21.1
REL	Points	24.4	7	45	3.9	16.2
UDE	Points	34.6	10	50	6.3	18.1
TDI	Points	19.5	3	50	5.6	28.7
TEP	Points	17.8	1	39	5.3	29.7
MSL	Points	25.1	5	48	4.7	18.7
FIS	Points	86.3	62	93	3.5	4.1

Min - minimum; Max - maximum; SD - standard deviation; CV - coefficient of variation; MP - milk production; KA - kidding age; STA - stature; STR - strength; DAI - dairyness; RAN - rump angle; RUW - rump width; FUA - fore udder attachment; RUH - rear udder height; RUA - rear udder arch; REL - rear legs; UDE - udder depth; TDI - teat diameter; TEP - teat placement; MSL - medial suspensory ligament; FIS - final score.

Table 2 - Results of the final mixed model for the average of somatic cell score per lactation in Nubian goats of the United States (n = 3716)

Variable	Estimate	Standard error	Probability value
Intercept	4.6880574	0.121733	<0.0001
Stature	0.0082141	0.001505	<0.0001
Strength	0.013984	0.002424	<0.0001
Rump width	0.0094316	0.002529	0.0002
Fore udder attachment	-0.010722	0.002131	<0.0001
Udder depth	-0.010934	0.001337	<0.0001
Teat diameter (TDI)	0.0065403	0.001603	<0.0001
Teat placement	0.0058107	0.00154	0.0002
Medial ligament suspensory (MLS)	0.0062055	0.001825	0.0007
Quadratic MLS	-0.000415	0.000211	0.0487
Quadratic TDI	-0.00062	0.000141	<0.0001

4. Discussion

The average of SCC was lower than the average of goats reported in the United States (570×10^3 cells/mL; Paape et al., 2007) and New Zealand (653×10^3 cells/mL; Apodaca-Sarabia et al., 2009), but greater than goats with low milk production from Chile (316×10^3 cells/mL; Marín et al., 2010). Milk production was higher than the yield of other Nubian goat populations (Bidot Fernández, 2013; Marín et al., 2010). Averages of points for type traits obtained in this study were similar to those obtained by Castañeda-Bustos et al. (2017) for a set of different breeds of US dairy goats, except for FIS and UDE, which were higher (86.3 and 34.6 vs. 83.8 and 31.4 points, respectively), and lower for TDI and RUA (19.5 and 25.9 vs. 23 and 31.4, respectively).

No literature was found on the specific variation due to HY for somatic cells in goats. However, the environmental variation for somatic cells in Alpine and Saanen goats was greater (around 3.5 times)

than the genetic variation (Rupp et al., 2011), and for conformation traits (approximately 1.8 times) as well (Luo et al., 1997), since it includes herd, year, and season of kidding, parity, and age at kidding, among other sources of variation. Herd effects accounted for 22 to 31, 24 to 25, and 15 to 25% of the variation in milk yield, fat yield, and fat percentage in goats (Iloje et al., 1981).

While intramammary infection increases ASCS for goats, other non-infectious factors such as age, estrus, season, advanced lactation, and milk yield will also increase SCC in goat milk to a greater degree than in cows (Paape et al., 2007). That biological difference may partially explain the low correlation values found in this study. Rupp et al. (2011) found similar results in the French Saanen breed, since seven out of eleven genetic correlations estimated between udder type traits and a mean lactation SCS were ≤ 0.10 in absolute values.

The linear and non-linear relationships found in the present study between ASCS with some conformation traits should be evaluated in other breeds and populations of dairy goats to deepen their knowledge and establish criteria for the reduction of somatic cells using conformation traits. When evaluating the relationship between two variables, it is important to determine how the variables are related. Linear relationships are very common, but variables can also have a nonlinear relationship. A linear relationship is a trend in the data that can be modeled as a straight line, while nonlinear relationships appear as a curve. If a relationship between two variables is not linear, the rate of increase or decrease can change as a variable change, causing that "curve pattern" in the data. In a nonlinear relationship, the variables tend to move in the same relative direction, but not necessarily at a constant rate (method of multiple regression analysis; Rawlings et al., 1998).

5. Conclusions

This is the first study that shows linear and non-linear relationships between lactation and conformation traits, and the average of somatic cell score for the entire lactation of Nubian goats in the United States. Although some statistically significant linear and nonlinear relationships were found between average somatic cells and some conformation traits, the contribution of each trait to explain somatic cell variation was low. All correlations estimated between average somatic cells and type traits were low as well. Relationships based on the present study are phenotypic and, therefore, include genetic and environmental effects that can influence the two traits simultaneously. Our results suggest that conformation traits should not be used for the prediction of lactation average somatic cell counts, at least for the Nubian breed population used in this study. It is necessary to estimate genetic parameters to assess if type traits can be used as criteria in genetic improvement programs to reduce somatic cell counts.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization: C.A. Ángel-Sahagún, A.J. Gutiérrez-Chávez and M. Valencia-Posadas. Data curation: S.B. Campos-Castillo and L. Shepard. Formal analysis: J.A. Hernández-Marín. Investigation: A.A. Lechuga-Arana. Methodology: H.H. Montaldo and M. Valencia-Posadas. Supervision: H.H. Montaldo. Visualization: J.A. Hernández-Marín. Writing-original draft: C.A. Ángel-Sahagún and S.B. Campos-Castillo. Writing-review & editing: M. Valencia-Posadas.

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References

- ADGA - American Dairy Goat Association. 2012. American Dairy Goat Association Guide Book. Spindale, NC. Available at: <<http://www.adga.org>>. Accessed on: Oct. 18, 2020.
- ADGA - American Dairy Goat Association. 2014. Linear appraisal system for dairy goats; Linear Appraisal Program. Spindale, NC, USA. 17p.
- ADGA - American Dairy Goat Association. 2018. ADGA breed standards. Available at: <<http://adga.org/breed-standards/>>. Accessed on: Nov. 16, 2020.
- Apodaca-Sarabia, C. A.; Lopez-Villalobos, N.; Blair, H. T. and Prosser, C. G. 2009. Genetic parameters for somatic cell score in dairy goats estimated by random regression. *Proceedings of the New Zealand Society of Animal Production* 69:206-209.
- Barrón-Bravo, O. G.; Gutiérrez-Chávez, A. J.; Ángel-Sahagún, C. A.; Montaldo, H. H.; Shepard, L. and Valencia-Posadas, M. 2013. Losses in milk yield, fat and protein contents according to different levels of somatic cell count in dairy goats. *Small Ruminant Research* 113:421-431. <https://doi.org/10.1016/j.smallrumres.2013.04.003>
- Bidot Fernández, A. 2013. Producción de leche de cabra y duración de la lactancia de los genotipos Nubia, Saanen y Toggenburg en condiciones de pastoreo restringido y suplemento con concentrado. *Abanico Veterinario* 3:30-35.
- Castañeda-Bustos, V. J.; Montaldo, H. H.; Torres-Hernández, G.; Pérez-Elizalde, S.; Valencia-Posadas, M.; Hernández-Mendo, O. and Shepard, L. 2014. Estimation of genetic parameters for productive life, reproduction, and milk-production traits in US dairy goats. *Journal of Dairy Science* 97:2462-2473. <https://doi.org/10.3168/jds.2013-7503>
- Castañeda-Bustos, V. J.; Montaldo, H. H.; Valencia-Posadas, M.; Shepard, L.; Pérez-Elizalde, S.; Hernández-Mendo, O. and Torres-Hernández, G. 2017. Linear and nonlinear genetic relationships between type traits and productive life in US dairy goats. *Journal of Dairy Science* 100:1232-1245. <https://doi.org/10.3168/jds.2016-11313>
- Haenlein, G. F. W. 2002. Relationship of somatic cell counts in goat milk to mastitis and productivity. *Small Ruminant Research* 45:163-178. [https://doi.org/10.1016/S0921-4488\(02\)00097-4](https://doi.org/10.1016/S0921-4488(02)00097-4)
- Iloje, M. U.; Van Vleck, L. D. and Wiggans, G. R. 1981. Components of variance for milk and fat yields in dairy goats. *Journal of Dairy Science* 64:2290-2293. [https://doi.org/10.3168/jds.S0022-0302\(81\)82844-5](https://doi.org/10.3168/jds.S0022-0302(81)82844-5)
- INBA - International Nubian Breeders Association. 2018. Nubian breed standards. Available at: <<http://www.i-n-b-a.org/standards.htm>>. Accessed on: Dec. 03, 2020.
- Jimenez-Granado, R.; Sanchez-Rodriguez, M.; Arce, C. and Rodriguez-Estevez, V. 2014. Factors affecting somatic cell count in dairy goats: a review. *Spanish Journal of Agricultural Research* 12:133-150.
- Luo, M. F.; Wiggans, G. R. and Hubbard, S. M. 1997. Variance component estimation and multitrait genetic evaluation for type traits of dairy goats. *Journal of Dairy Science* 80:594-600. [https://doi.org/10.3168/jds.S0022-0302\(97\)75975-7](https://doi.org/10.3168/jds.S0022-0302(97)75975-7)
- Marín, M. P.; Fuenzalida, M. I.; Burrows, J. and Gecele, P. 2010. Recuento de células somáticas y composición de leche de cabra, según nivel de producción y etapa de lactancia, en un plantel intensivo de la zona central de Chile. *Archivos de Medicina Veterinaria* 42:79-85. <https://doi.org/10.4067/S0301-732X2010000200009>
- Montaldo, H. and Martínez-Lozano, F. J. 1993. Phenotypic relationships between udder and milking characteristics, milk production and California mastitis test in goats. *Small Ruminant Research* 12:329-337. [https://doi.org/10.1016/0921-4488\(93\)90068-S](https://doi.org/10.1016/0921-4488(93)90068-S)
- Montaldo, H. H.; Torres-Hernández, G. and Valencia-Posadas, M. 2010. Goat breeding research in Mexico. *Small Ruminant Research* 89:155-163. <https://doi.org/10.1016/j.smallrumres.2009.12.039>
- Paape, M. J.; Wiggans, G. R.; Bannerman, D. D.; Thomas, D. L.; Sanders, A. H.; Contreras, A.; Moroni, P. and Miller, R. H. 2007. Monitoring goat and sheep milk somatic cell counts. *Small Ruminant Research* 68:114-125. <https://doi.org/10.1016/j.smallrumres.2006.09.014>
- Rawlings, J. O.; Pantula, S. G. and Dickey, D. A. 1998. Applied regression analysis. A research tool. 2nd ed. Springer, New York, USA.
- Rupp, R.; Clément, V.; Piacere, A.; Robert-Granié, C. and Manfredi, E. 2011. Genetic parameters for milk somatic cell score and relationship with production and udder type traits in dairy Alpine and Saanen primiparous goats. *Journal of Dairy Science* 94:3629-3634. <https://doi.org/10.3168/jds.2010-3694>
- Schaeffer, L. R. 2009. Contemporary groups are always random. Available at: <<https://animalbiosciences.uoguelph.ca/~lrs/piksLRS/ranfix.pdf>>. Accessed on: Jul. 15, 2016.
- Scholtens, M. R.; Lopez-Villalobos, N.; Garrick, D.; Blair, H.; Lehnert, K. and Snell, R. 2020. Genetic parameters for total lactation yields of milk, fat, protein, and somatic cell score in New Zealand dairy goats. *Animal Science Journal* 91:e13310. <https://doi.org/10.1111/asj.13310>
- Torres-Vázquez, J. A.; Valencia-Posadas, M.; Castillo-Juárez, H. and Montaldo, H. H. 2009. Genetic and phenotypic parameters of milk yield, milk composition and age at first kidding in Saanen goats from Mexico. *Livestock Science* 126:147-153. <https://doi.org/10.1016/j.livsci.2009.06.008>

USDA - United States Department of Agriculture. 2002. The goat industry: structure, concentration, demand and growth. Electronic Report from APHIS. Available at: <https://www.aphis.usda.gov/animal_health/emergingissues/downloads/goatreport090805.pdf>. Accessed on: Jan. 02, 2021.

VanRaden, P. M.; Cole, J. B. and Parker Gaddis, K. L. 2018. Net merit as a measure of lifetime profit: 2018 revision. Animal Improvement Programs Laboratory, ARS-USDA, Beltsville, MD. Available at: <<https://aipl.arsusda.gov/reference/nmcalc-2018.htm>>. Accessed on: Jan. 02, 2021.

Wiggans, G. R. and Shook, G. E. 1987. A lactation measure of somatic cell count. *Journal of Dairy Science* 70:2666-2672. [https://doi.org/10.3168/jds.S0022-0302\(87\)80337-5](https://doi.org/10.3168/jds.S0022-0302(87)80337-5)

Wiggans, G. R. and Hubbard, S. M. 2001. Genetic evaluation of yield and type traits of dairy goats in the United States. *Journal of Dairy Science* 84(E. Suppl):E69-E73. [https://doi.org/10.3168/jds.S0022-0302\(01\)70199-3](https://doi.org/10.3168/jds.S0022-0302(01)70199-3)

Zeng, S. S. and Escobar, E. N. 1995. Effect of parity and milk production on somatic cell count, standard plate count and composition of goat milk. *Small Ruminant Research* 17:269-274. [https://doi.org/10.1016/0921-4488\(95\)00658-8](https://doi.org/10.1016/0921-4488(95)00658-8)