Research Note

HAIR DIAMETER COMPARISON BETWEEN SLICK- AND WILD TYPE-HAIRED PUERTO RICAN HOLSTEIN COWS[1, 2]

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J. Agric. Univ. P.R. 103(2):183-187 (2019)

Induced by multiple anecdotes of local farmers associating a shorter hair coat with greater productivity in dairy cows, the author's group has dedicated the last four years to characterizing Puerto Rican dairy cattle according to hair coat type. Based on these efforts we have established that Puerto Rican slick-haired dairy cows (SLICK) demonstrate superior adaptation to tropical weather than their wild type-haired counterparts (WT; Castro et al., 2015; Sánchez et al., 2015; Sánchez-Rodríguez et al., 2016; Sánchez and Domenech, 2018). This thermoregulatory advantage has been associated with greater reproductive (personal communication with Rafael López, dairy farmer of Camuy, Puerto Rico) and productive performance (Contreras-Correa et al., 2016). It is known that a shorter hair coat allows for greater heat dissipation (Hansen, 2004), which may positively impact productivity in cattle. However, such superiority should be multifactorial in nature. For instance, it has also been determined that Puerto Rican SLICK cows have larger sweat glands than their WT relatives (Contreras-Correa et al., 2017; Muñiz-Cruz et al., 2018), similar to other cattle breeds highly adapted to the tropics (Hansen, 2004). In addition to a shorter hair coat, others have suggested a larger hair diameter as one of the adaptations of tropical cattle (Gaughan et al., 2009). However, such a characteristic had not been evaluated by the author's group. Another group at UPR-Mayagüez measured hair length and width (Jiménez-Cabán et al., 2015). The present study aimed to compare hair diameter values between SLICK and WT Puerto Rican Holstein cows.

Following aseptic procedures, a skin biopsy (6 mm in diameter; Integra, Miltex Standard Biopsy Punches, Plainsboro, NJ)[4] was collected immediately cranial to the right shoulder from 15 SLICK and 19 WT Puerto Rican Holstein cows injected with a local anesthesia. All cows were obtained from the lactating herd at the Agricultural Research Station in Lajas, Puerto Rico. The skin biopsies were fixed in 10% formalin in individual biopsy cassettes (Shandon Biopsy Processing/Embedding Cassettes) previously identified by cow and hair coat type. Cows were phenotypically selected and genomically confirmed for hair coat type. The fixed biopsies were individually photographed by a Canon EOS 7D Mark II camera and the Camlift V2.7.0 software. The Zerene Stacker (64-bit) software was used to compress multiple photographs of each biopsy. A measurement scale of 0.5 mm was set by Photoshop 6.0

[1]Manuscript submitted to Editorial Board 10 September 2018.

[2]The author acknowledges José Almodóvar (University of Puerto Rico at Mayagüez Campus, Department of Biology) for his assistance with the biopsy photographs, and Juliana Nieves, Melanie Rivera, Victoria Blas, Yaneska Sein and Carolina Luciano for taking the hair diameter measurements.

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[4]Company or trade names in this publication are used only to provide specific information. Mention of a company or trade name does not constitute an endorsement by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

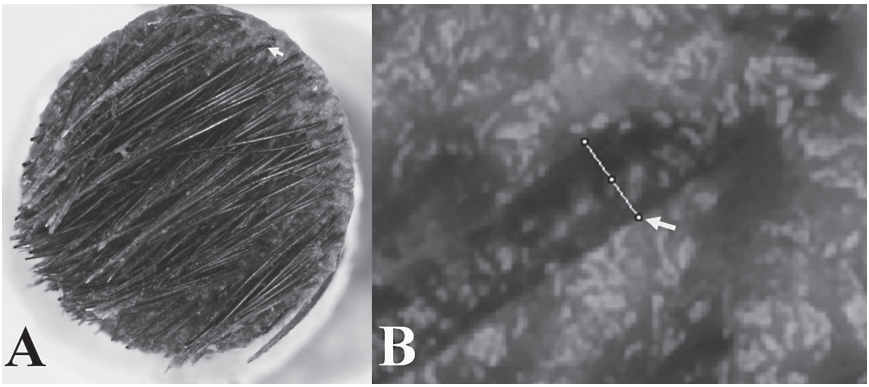

FIGURE 1. One of the skin biopsies evaluated from a slick-haired cow (A) and its magnification showing the longitudinal caliper used to measure the hair diameter (B, see arrows). Note that calipers were placed perpendicular to the hair shaft and at the base of the hair. Hairs were clipped to facilitate cleaning and disinfection during biopsies sampling.

(Adobe, San Jose, CA). Hair diameter was measured at the base of five hairs (perpendicular to the hair shaft; Figure 1) in each biopsy by the ImageJ software (v. 1.31; accessible free from http://rsbweb.nih.gov/ij/). The hairs to measure in each biopsy were randomly selected by the author, so that the same five hairs were independently evaluated by five different technicians (a total of 25 diameter values / skin biopsy were obtained). The obtained hair diameters were averaged by each skin biopsy – technician combination, resulting in a dataset containing five diameter values per cow. Normal distribution was verified by the Proc Univariate, and comparisons between hair coat types were carried out by Proc GLIMMIX, both in SAS. Hair diameter and hair coat type were included as the dependent variable and fixed effect in the model, respectively. The cow identification and technician name were considered random effects. Significant differences were established at a $P \leq 0.05$.

In this study, no differences in hair diameter were observed between SLICK and WT Puerto Rican Holstein cows (0.0858 ± 0.0014 and 0.0838 ± 0.0015 mm, respectively; P=0.6291). Respective hair diameter ranges of 0.0555 to 0.1182 mm and 0.0590 to 0.1208 mm were observed. Table 1 shows a literature review of the hair diameter values previously published by others who evaluated tropically adapted Holstein cattle from Brazil (Bertipaglia et al., 2005; Campos et al., 2005a, 2005b; Campos et al., 2009). In our study, the mean hair diameter values observed in both the SLICK and the WT cows fall within the range of those in the literature. Based on assumptions made from the literature, Campos et al. (2005a, 2005b) suggested that hair diameter should be larger in tropically adapted than in temperate cattle breeds. According to the present study, however, the Puerto Rican WT and SLICK cows had similar hair diameters, and both hair coat group values were similar to those previously published in the literature for tropical Holstein cattle, suggesting that considerable adaptation to hot weather has also been achieved by the Puerto Rican WT group. The term adaptation has been defined by Bligh and Johnson (1973) as "a change which reduces the physiological strain produced by a stressful component of the total environment" that may be "the result of genetic selection." Thus, because substantial importations of Holstein cattle to Puerto Rico began during the 1950s (Sánchez-Rodríguez, 2019) and the experimental animals were obtained from a closed herd (i.e., with no introductions of cattle for considerable time), adaptation through multiple generations of selection may be reasonably expected in both hair coat groups, probably resulting in the observed similar hair diameter values. Much like the

TABLE 1.—*Literature review of hair diameter values in tropically adapted Holstein cattle.*

Animals	n	Hair diameter, mm (mean ± standard error)	Hair diameter range, mm	Reference
Holstein cows	939	0.0625 ± 0.0056	0.0441 - 0.0977	Bertipaglia et al., 2005
Holstein cows	973	0.0608 ± 0.0005	0.0576 - 0.0643	Campos et al., 2005a
Holstein cows	449	0.0622 ± 0.0002	—	Campos et al., 2005b
Holstein heifers and cows	973	0.0620 ± 0.0001	—	Campos et al., 2009

Note. All evaluated animals were obtained from the tropical region of Brazil. Hair samples were obtained from the thorax, 20 cm below dorsal line, in the studies of Bertipaglia et al. (2005), Campos et al. (2005a) and Campos et al. (2005b); and from the flank, 20 cm below dorsal line, in the Campos et al. (2009) study.

anecdotes of Puerto Rican dairy farmers regarding the reproductive performance of their cattle, in the tropical Holstein cows evaluated by Bertipaglia et al. (2005) and Campos et al. (2005b), a shorter hair coat resulted in superior fertility; however, hair diameter was not associated with reproductive performance in these studies. The analysis of hair samples from Holstein cows imported from northern United States at the time of arrival in Puerto Rico may help to clarify this theory.

LITERATURE CITED

Bertipaglia, E.C.A., R.G. Silva and A.S.C. Maia, 2005. Fertility and hair coat characteristics of Holstein cows in a tropical environment. *Anim. Reprod.* (Belo Horizonte) 2: 187-194.

Bligh, J. and K.G. Johnson, 1973. Glossary of terms for thermal physiology. *J. Appl. Physiol.* 35(6): 941-961.

Campos, A.S.C., R. Gomes and E.C. Abaker, 2005a. Environmental and genetic variation of the effective radiative properties of the coat of Holstein cows under tropical conditions. *Livest. Prod. Sci*. 92: 307-315.

Campos, A.S., R. Gomes, E.K. Abaker and M. Cerón, 2005b. Genetic variation of the hair coat properties and the milk yield of Holstein cows managed under shade in a tropical environment. *Braz. J. Vet. Res. Anim. Sci.* 42(3): 180-187.

Campos, A.S., R. Gomes, J.B. Freire, R. Batista and H.G. Tertulino, 2009. Effective thermal conductivity of the hair coat of Holstein-Friesian cows in a tropical environment. *R. Bras. Zootec.* 38(11): 2218-2223.

Castro, A., G. Muñiz, J. Curbelo, M. Pagán, A. Mesonero, A. de Jesús, N. Lluch and H. Sánchez, 2015. Effect of the environmental conditions over the vaginal temperature and respiration rate on wild type and slick-haired Puerto Rican Jersey cows. Joint Annual Meeting ADSA-ASAS 2015. Orlando, FL. July 12, 2015.

Contreras-Correa, Z., G. Muñiz-Colón, M. Pagán-Morales, A. Mesonero-Morales, J. Curbelo-Rodríguez and H.L. Sánchez-Rodríguez, 2016. Hematocrit, milk yield, and production related parameters comparisons between slick and wild type-haired Puerto Rican Holstein cows. Joint Annual Meeting, ASAS-ADSA-CSAS-WSASAS. Salt Lake City, UT. July 19-23, 2016.

Contreras-Correa, Z.E., N. Peña-Alvarado, W. Torres-Ruiz, J.R. Almodóvar-Rivera, K.I. Domenech-Pérez, C. Youngblood, M. Pagán-Morales, A. Mesonero-Morales, J. Curbelo-Rodríguez, P.F. Randel-Follin, G.C. Muñiz-Colón, V. Colón-González, Á.L. Jiménez-Arroyo, G.M. Jiménez-Arroyo and H.L. Sánchez-Rodríguez, 2017. Slick-haired Puerto Rican Holstein cows have larger sweat glands than their wild type-haired counterparts. ADSA 2017. Pittsburgh, PA. June 25-28, 2017.

Gaughan, J.B., N. Lacetera, S.E. Valtorta, H.H. Khalifa, L. Hahn and T. Mader, 2009. Response of domestic animals to climate challenges. *In:* Biometeorology of adaptation to climate variability and change (eds K.L Ebi, I. Burton and G.R. McGregor), pp 151-152. Springer Science, Heidelberg, Germany.

Hansen, P.J., 2004. Physiological and cellular adaptations of zebu cattle to thermal stress. *Anim. Reprod. Sci*. 83:349-360.

Jiménez-Cabán, E., A. Riera and M. Pagán-Morales, 2015. Correlation of hair length and width with genetic potential for productive traits in Puerto Rican Holstein cattle. *J. Agric. Univ. P.R.* 99(1): 13-18.

Muñiz-Cruz, J.M., N. Peña-Alvarado, W. Torres-Ruiz, J.R. Almodóvar-Rivera, K.I. Domenech-Pérez, Z.E. Contreras-Correa, G.C. Muñiz-Colón, A.C. Cortés-Arocho, J.M. Santiago-Rodríguez, S. Ruiz-Ríos, G.A. Soriano-Varela, N.N. Cortés-Viruet, A.L. Jiménez-Arroyo, G.M. Jiménez-Arroyo and H.L. Sánchez Rodríguez, 2018. Sweat gland cross-sectional cut areas comparisons between slick and wild type-haired Holstein and Senepol cows in Puerto Rico. ADSA 2018. Knoxville, TN. June 24-27, 2018.

Sánchez, H., A. Castro, M. Pagán, J. Curbelo, A. Mesonero and G. Muñiz, 2015. Effects of the thermal humidity index on vaginal temperature of slick- and wild type-haired Puerto Rican Holstein cows. Joint Annual Meeting ADSA-ASAS 2015. Orlando, FL. July 12-16, 2015.

Sánchez-Rodríguez, H.L., 2019. Revisión histórica y científica sobre el desarrollo de la ganadería de leche en Puerto Rico con énfasis en el ganado pelón. *J. Agric. Univ. P. R.* 103(1): 107-139.

Sánchez-Rodríguez, H.L. and K. Domenech-Pérez, 2018. Relationship between air and vaginal temperatures in wild type and slick-haired Puerto Rican Holstein cows. ADSA 2018. Knoxville, TN. June 24-27, 2018.

Sánchez-Rodríguez, H.L., Z. Contreras-Correa, M. Pagán-Morales, J. Curbelo-Rodríguez, A. Mesonero-Morales, C. Cabrera-Cabrera and G. Muñiz-Colón, 2016. Associations between the environmental conditions and vaginal temperature in wild-type and slick-haired Puerto Rican Holstein cows. Joint Annual Meeting, ASAS-ADSA-CSAS-WSASAS. Salt Lake City, UT. July 19-23, 2016.