Advance in Agriculture and Biology
www.pscipub.com/AAB
E-ISSN: 2310-9343 / P-ISSN: 2311-0163
DOI: 10.15192/PSCP.AAB.2014.1.1.Article4

Adv. Agric. Biol.
1 (1), 2014: 17-19

Possible tendency of longer horns towards shorter ears in goats

Parés-Casanova, P.M[1], Kucherova, I[2]

1. Department of Animal Production. University of Lleida. Lleida. Catalunya (Spain)
2. Pere M. Parés-Casanova. Department of Animal Production, Av. Alcalde Rovira Roure, 191 (E-25198 Lleida). Catalunya (Spain).
Corresponding author email: peremiquelp@prodan.udl.cat

Paper Information

Received: 10 December 2013

Accepted: 11 January 2014

Published: 20 January 2014

A B S T R A C T

A study was designed to evaluate the correlation in ear and horn sizes, in both cases as keys to body thermoregulation. For this purpose, measurements of the horn (length and perimeter) and ears (length and width) were obtained from 23 adult Catalan Goat (*Cabra Catalana*) females. A negative significant correlation between ear and horn size was obtained. According to this research, both horns and ears would contribute to thermoregulation; this function being not therefore solely a function of having big or small horns, as has normally been stated to be the case. Although the studied sample is small, obtained results would indicate interesting hypotheses for future study of goat breeds.

Key words: *Cabra Catalana; Catalan Goat; heat stress; horns; thermoregulation*

Introduction

Heat stress in feedlot cattle causes reduced performance (Brown-Brandl *et al.,* 2005). The failure of homeostasis at high temperatures may lead to reduced productivity or even death (Blackshaw and Blackshaw, 1994; Brown-Brandl *et al.,* 2005). At high temperatures, evaporative cooling is the principal mechanism for heat dissipation in cattle (Blackshaw and Blackshaw, 1994). Supportive evidence for a thermoregulatory (temperature-regulating) function of bovid horns has been provided by Picard *et al.* (1999), as the anatomy and physiology of bovid horns are consistent with their thermoregulatory function, and little data exists on this topic for goats.

Horns consist of a bony core, which is an extension of the frontal bone, and a keratinous horn sheath growing over it. It is covered by a double layer of fused tissues: the periosteum adjacent to the core and the corium adjacent to the sheath. These tissues produce annual additions to the sheath as well as to the core, and they are highly vascularized (Taylor, 1960). In contrast with the core, the keratin sheath is a non-living appendage, and appears to be a poor insulator of the heat-radiating core surface (Taylor, 1966; Picard *et al*., 1999) so there is potential for bovids to use their horns as part of their thermoregulatory processes. In goats, it has been demonstrated that horns vasodilate in response to heat stress, exercise and blocking of their nerves, and vasoconstrict when animals are placed in the cold (Hammel and Pierce, 1968).

Research has shown that in temperate species the surface area of the vascularized inner core is reduced while the thickness of the outer keratin sheath is increased. This limits heat loss from the horns, which would cause a negative welfare in colder climates. Studies dealing with thermoregulatory reactions to heat exposure are not undertaken frequently in domestic mammals, and affects on circulatory function have not been reported, although there is a substantial literature on wild mammalian thermoregulation. In fact, the regulatory function of ears for different wild species is widely known in, for example, rabbits (Harada, 1973; Fayez *et al*., 1994), jackrabbits (Hill *et al*., 1980), elephants (Vanitha and Baskaran, 2010) and bats (Lyman, 1970).

So, if ears and horns have been described as having a thermoregulatory function (although, certainly, not the only structures related to this control, as respiration and the nasal mucosae are other important heat dissipation pathways), why not suppose they can be morphologically related?

This study was designed to evaluate differences in ear size, as coadjuvant keys of body thermoregulation, in she-goats belonging to the *Cabra Catalana* breed. This is a small population composed of individuals from different origins, and is considered to be the last remnants of the ancient "Raça Catalana" (Catalan breed). The breed occupied Catalunya (NE Spain) until the mid 20th century, and was well adapted to harsh interior Mediterranean areas in the Catalan Pre-Pyrenees region. The breed is medium-sized, has a slender neck and a sloping rump, is relatively long-legged and short-haired with characteristic long hair on the upper thigh, and has a haired udder. Both sexes have horns, typically sharply backwards ("aegagrus" type),

although some have corkscrew-shaped horns, curving back and out ("prisca" type). It is clearly different from other Catalan neighbouring breeds, e.g. Pyrenean and White de Rasquera. Some years ago, a group of volunteers from "Cultures Trobades" ("Slow Food Terres de Lleida") made an effort to gather the last individuals, and relocated them to a safer place under better management, starting a program to preserve them. Only two pure males remain, and they were excluded from this study.

Materials and methods

Four measurements of 23 adult females were taken by the second author (IK). Measurements were: ear length, ear width, horn length and horn perimeter (base) for both sides. To test the pattern of normality of distributions, the Shapiro-Wilk test was applied (Shapiro and Wilk, 1965). Correlation was tested with the Spearman coefficient, which assesses how well the relationship between two variables can be described using a monotonic function. If there are no repeated data values, a perfect Spearman correlation of +1 or −1 occurs when each of the variables is a perfect monotone function of the other. Linear regression was obtained with the ordinary least-square method, using log-transformed data. This is a method for estimating the unknown parameters in a linear regression model. This method minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation.

Statistical analysis

For all tests, probability levels lower than 5% were considered significant. All statistical procedures were performed with the PAST package (Hammer *et al*., 2001).

Ethical statement

No ethical statement is considered necessary as animals were subjected to minimal stress and no cruel manipulation.

Results

The linear measurements obtained showed a normal distribution only for ear length ($p<0.05$). Main descriptive statistics are shown in Table 1. There appeared to be a significant positive correlation in ear size (length and width) and horn size (length and perimeter) (Table 2) with a negative correlation between horn length and ear length, thus showing a tendency of animals with longer horns to have smaller ears (Figure 1).

Table 1. Main descriptive statistics (n=47).

	Ear width	Ear length	Horn length	Horn perimeter
Min	7.0	13.0	19.0	10.5
Max	9.0	19.0	53.0	17.0
Average (SE)	7.7 (0.08)	15.7 (0.20)	37.7 (1.10)	13.4 (0.23)
Shapiro-Wilk	0.857	0.971	0.946	0.943
P	<<<0.0001	0.309	0.032	0.023

Average values in cm.

Table 2. Correlation between variables (Spearman coefficient below diagonal; probabilities above the diagonal). Significant correlations appear in bold.

	Ear width	Ear length	Horn length	Horn perimeter
Ear width		0.034528	0.14964	0.54163
Ear length	0.30907		0.015744	0.75965
Horn length	0.21348	-0.35042		0.006381
Horn perimeter	0.091301	-0.04584	0.39233	

Discussion

As the mass (body weight) of animals must be considered equal because all were adult females, their index of thermoregulatory potential, which takes into account the mass of the animal (Hoefs, 2000), was also considered to be the same.

The process for heat exchange works by blood being pumped around the 'core' of the horn – the part containing the blood vessels – and as this blood passes close to the outside part of the horn, heat is lost to the atmosphere and cooler blood returns to the body of the animal. Ears are packed with capillary structures through which a sizeable quantity of blood flows (Narasimhan, 2008). So, the vascularization of the ear would compensate for this response with less horn surface. In fact, according to the research undertaken, it appears that the horn and ear surfaces of Catalan goat are adapted to regulate heat loss. In any case, thermoregulation in this breed would not be solely a function of having or not having long horns, as it appears that ear size a response to climatic conditions.

The evolvement of ears and horns in the Catalan Goat could be mainly for adaptive purposes. The negative correlation between ear and horn surface should be investigated for other goat breeds, especially those highly adapted to extreme

environments, on the basis that ear and horn conformation are not solely to be viewed as ornamental structures or simply secondary traits to characterize a breed morphologically.

It is now important to complete research in adult animals, in which most growth has been completed. Although the sample is small, the obtained results indicate interesting hypotheses for future research, especially those devoted to establish a good racial standard.

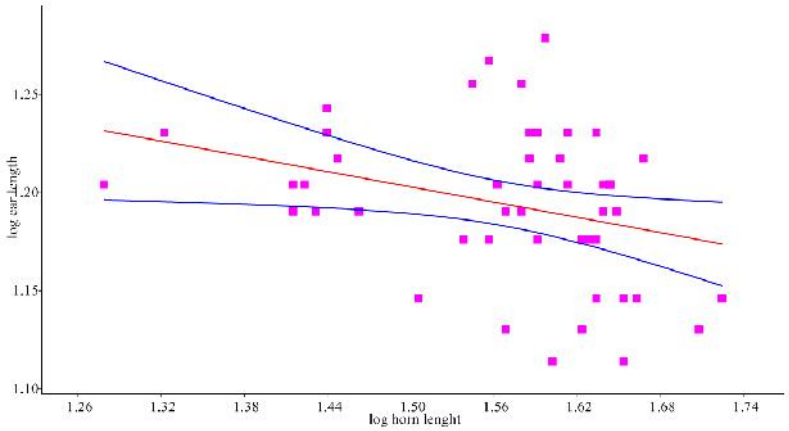

Figure 1. Linear regression of horn length *versus* ear length (ordinary LS method), showing a tendency of animals with longer horns to have shorter ears. Values log transformed. r_s=-0.35042 (p=0.01).

Acknowledgements

We wish to thank Artur Bòria and Gerard Batalla from "Cultures Trobades" ("Slow Food Terres de Lleida") who kindly allowed access to their pure-breed herd.

References

Blackshaw JK, Blackshaw AW. 1994. Heat stress in cattle and the effect of shade on production and behaviour: a review. Aust J Exp Agr; 34(2):285-295.

Brown-Brandl TM, Eigenberg RA, Hahn GL, Nienaber JA, Mader TL. 2005. Analyses of thermoregulatory responses of feeder cattle exposed to simulated heat waves. Int J Biometeorol; 49(5):285-296.

Fayez I, Marai M, Alnaimy A and Habeeb M. 1994. Thermoregulation in rabbits**.** In : Baselga M. (ed.), Marai I.F.M. (ed.). Rabbit production in hot climates. Zaragoza: CIHEAM, p. 33-41. (Cahiers Options Méditerranéennes; n. 8). I International Conference of rabbit production in hot climates, 1994/09/06-08, Cairo (Egypt).

Hammel HT, Pierce JB. 1969. Regulaion of Internal Body Temperature. Annu Rev Physiol; 30:641-710.

Hammer Ø, Harper DAT, Ryan PD. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontol Electron; 4(1). On line http://palaeo-electronica.org/2001_1/past/issue1_01.html.

Harada E. 1973. The role of the rabbit ear in thermoregulation and in cold acclimation. Jap. J. vet. Res. 1973; 21:160-161.

Hill RW. 1980. Pinna temperature in exercising jackrabbits, *Lepus californicus*. Journal of Mammalogy; 61:30–38.

Hoefs M. 2000. The thermoregulatory potential of *Ovis* horn cores. Can J Zool 2000; 78:1419-1426.

Lyman CP. 1970. Thermoregulation and metabolism in bats. In Biology of bats, W.A. Wimsatt ed. Academic press, New York, 1970; p. 301-330

Narasimhan A. 2008. Why do Elephants have Big Ear Flaps? Resonance; July:638-647.

Picard K, Thomas D, Festa-Bianchet M, Belleville F, Laneville A. 1999. Differences in the thermal conductance of tropical and temperate bovid horns. Ecoscience; 6 (2):148-158.

Shapiro SS, Wilk MB. 1965. An analysis of variance test for normality (complete samples). Biometrika; 52:591-611.

Taylor RA. 1960. Characteristics of horn growth in bighorn rams. M.S. thesis. Montana State University, Bozeman.

Taylor CR. 1966. The vascularity and possible thermoregulatory function of the horns in goats. Physiol Zool; 39:127-139.

Vanitha V, Baskaran N. 2010. Seasonal and Roofing Material Influence on the Thermoregulation by Captive Asian Elephants and its Implications for Captive Elephant Welfare. Gajah; 33:35-40.