Short Communication

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Possible tendency of polled cattle towards larger ears¤

Presumible tendencia del bovino aquerato hacia orejas de mayor tamaño

Possível tendência do gado sem chifres a ter orelhas maiores

Pere M Parés-Casanova*, Vet, PhD; Marta Caballero, Lic.

Department of Animal Production, University of Lleida, Lleida, Catalunya (Spain).

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Summary

Background: the anatomy and physiology of bovid horns are consistent with their thermoregulatory function. **Objective:** to evaluate a possible correlation between ear and horn size, as key factors for body thermoregulation. **Methods:** measurements of horns (length and perimeter) and ears (length and width) were obtained from forty-six Pyrenean Brown (Bruna dels Pirineus) beef calves. The sample was randomly distributed between horned (n=34) and polled (n=12) animals, aged 332 ± 56 days. **Results:** a negative correlation between ear and horn size was observed ($p<0.05$) and the multivariate clustering demonstrated a tendency of polled animals towards bigger ear size. **Conclusions:** according to these results, horns and ears contribute to thermoregulation; this function is not therefore solely a function of big or small horns, as has normally been stated to be the case. Although the sample is small, results would indicate an interesting hypothesis for future research.

Key words: *Bruna dels Pirineus, heat stress, horns, Pyrenean Brown, thermoregulation.*

Resumen

Antecedentes: la anatomía y fisiología de los cuernos bovinos está relacionada con su posible función termoregulatoria. **Objetivo:** este estudio fue diseñado para evaluar la correlación entre el tamaño de los cuernos y de las orejas y su relación con la termorregulación. **Métodos:** se obtuvieron varias medidas de los cuernos (longitud y perímetro) y de las orejas (largo y ancho) en 46 terneros de la raza Parda de los Pirineos (Bruna dels Pirineus). La muestra se distribuyó aleatoriamente entre animales queratos (n=34) y aqueratos (n=12), con una edad promedio de 332 ± 56 días. **Resultados:** la correlación entre los tamaños auricular y cornual fue negativa ($p<0,05$), mostrándose a la vez, en el agrupamiento multivariado, una tendencia de los animales aqueratos a presentar orejas más grandes. **Conclusión:** a la vista de los resultados obtenidos en esta investigación, parecería que tanto los cuernos como las orejas contribuyen a la termorregulación, que no recaería entonces en tener solamente cuernos grandes o pequeños, como normalmente ha venido afirmándose.

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* Corresponding author: Pere M Parés-Casanova, Department of Animal Production, University of Lleida, Av. Alcalde Rovira Roure, 191, 25198-Lleida (Catalunya, Spain). Tel: +34 973706460, fax: +34 973702874. Email: peremiquelp@prodan.udl.cat

A pesar de que la muestra analizada es pequeña, los resultados obtenidos indicarían una hipótesis de trabajo interesante para investigaciones futuras.

Palabras clave: *Bruna dels Pirineus, cuernos, estrés calórico, Parda de los Pirineos, termorregulación.*

Resumo:

Antecedentes: a anatomia e fisiologia dos chifres no gado está relacionada à sua possível função de termorregulação. **Objetivo:** este estudo foi desenhado para avaliar a correlação entre o tamanho dos chifres e das orelhas e a sua relação com a termorregulação. **Métodos:** várias medidas dos chifres (perímetro e largura) e orelhas (comprimento e largura) em 46 bezerros da raça Brown nos Pirinéus (Bruna dels Pirineus) foram obtidas. A amostra foi aleatoriamente distribuida entre animais queratos (n=34) e aqueratos (n=12), com uma idade média de 332 ± 56 dias. **Resultados:** a correlação foi negativa entre tamanho da orelha e tamanhos cornuais (p<0,05), mostrando no agrupamento multivariado uma tendência de animais aqueratos para apresentar orelhas maiores. **Conclusão**: tendo em vista os resultados obtidos nesta investigação, parece que ambos os chifres e as orelhas contribuem para a termorregulação. Então, a termorregulação não só estaria em ter chifres grandes ou pequenos, como normalmente tem se afirmado. Apesar de a amostra analisada ser pequena, os resultados indicam uma hipótese interessante para futuras pesquisas.

Palavras chave: *Bruna dels Pirineus, chifres, estresse térmico, Parda Pirinéus, termorregulação.*

Introduction

Heat stress in feedlot cattle is associated with reduced performance (Brown-Brandl *et al.,* 2005). Homeostasis failure at high temperatures may lead to reduced productivity or even death (Blackshaw and Blackshaw, 1994; Brown-Brandl *et al.,* 2005). Evaporative cooling is the principal mechanism for heat dissipation in cattle submitted to high temperature environments (Blackshaw and Blackshaw, 1994). Picard *et al.* (1999) provided evidence for a thermoregulatory function of bovid horns. Anatomy and physiology of bovid horns are consistent with their thermoregulatory function.

Bovid horns consist of a bony core, which is an extension of the frontal bone with an exterior keratinous horn sheath. A double layer of fused tissues covers the core: 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. 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). There is potential for sheep, goats, cattle and bison to use their horns as part of their thermoregulatory (temperature-regulating) processes. In goats, it has been demonstrated that horns vasodilate in response to heat stress, exercise and blockage of local nerves, and vasoconstrict when animals are placed in the cold (Hammel and Pierce, 1968). In cattle, the Ankole Watusi, an African-native cattle breed, is a typical extreme case; this breed has horns that can grow up to six feet long, honeycombed with blood vessels. This is completely consistent with expectations, as the Ankole Watusi breed lives in areas where temperatures remain very high year round. The Texas Longhorn is another cattle breed known for its characteristic horns, which can extend up to 2.1 m wide tip-to-tip for steers and cows, and 0.91 to 2.0 m tip-to-tip for bulls.

Research has shown that in temperate species the surface area of the vascularized inner core is reduced while thickness of the outer keratin sheath increases, limiting heat loss through the horns, and improving animal welfare in colder climates.

Material and methods

No ethical statement was considered necessary as animals were slaughtered for commercial purposes independently of the purpose of this research. The study was designed to evaluate ear size differences in Bruna dels Pirineus calves. This breed is a Catalan (NE *Spain*) population of the Alpine trunk. Animals are rustic, brown-coated and well adapted to mountain pastures. Cows formerly had triple aptitude—milk, meat, and work—but today this breed is essentially used for meat production. The production system is characterized by being extensive: cattle spend the winter in valleys close to villages and the summer in mountainous passes. This cycle is determined by the rhythm of births and food availability throughout the year. Their tractability is highly appreciated by farmers. Certain strains are polled: that is, they naturally do not have horns.

Forty-six freshly cut calf heads were measured. Heads were obtained in an industrial abattoir. The sample was randomly distributed between males (n=19) and females (n=27), of which four males and eight females were naturally polled. Studied animals were aged 332 ± 56 days (range 226-573 days). They were raised in 24 different herds but were all managed under similar conditions in the same habitat.

Statistical analysis

Four measurements were taken of disarticulated complete heads: ear length and width, horn length and perimeter, for both sides. The Shapiro-Wilk test was applied (Shapiro and Wilk, 1965) to test for normality of distribution. Paired comparisons between measurements (right and left sides) were conducted using a Wilcoxon test. A one-way MANOVA (Multivariate ANalysis Of VAriance) was used to compare ear size between groups. If the MANOVA showed a significant overall difference between groups, the analysis proceeded to pairwise Hotelling's tests. Finally, a Canonical Variates Analysis (CVA) was performed. CVA produces a scatter plot of specimens along the two first canonical axes, producing maximal and second-to-maximal separation between all groups (multigroup discriminant analysis). The axes are linear combinations of the original variables. Probability levels lower than 5% were considered significant for all tests. All statistical procedures were performed with the PAST package (Hammer *et al*., 2001).

Results

The linear measurements obtained showed a normal distribution for all measurements. Ear measurements did not appear to be correlated with age. Paired comparisons showed no differences between left and right ears or for horn parameters, so average values were obtained for each parameter. The average values for polled/horned and males/females are shown in Table 1.

There appeared to be a significant negative correlation between ear size (length x width), and horn length and perimeter (Table 2), and the CVA scatter (Figure 1) showed a tendency for polled animals to have bigger ears.

Table 1. Ear and horn dimensions (cm) for polled and horned animals.

	Ear width	Ear length	Horn length	Horn perimeter
Horned females (n = 19)	12.5 ± 0.65	17.8 ± 0.99	9.6 ± 3.49	12.3 ± 2.27
Horned males (n = 15)	13.0 ± 0.94	18.4 ±0.91	12.7 ± 4.13	16.4 ± 2.98
Polled females (n = 8)	13.6 ± 0.25	18.6 ± 0.81	--	--
Polled males (n = 4)	13.9 ± 0.80	19.9 ± 0.51	--	--

Values are the average between both sides (right and left of the head).

Table 2. Correlation between ear size (width x length), horn length, and horn perimeter.

	Ear size	Horn length	Horn perimeter
Ear size		0.014	0.020
Horn length	-0.359		0.000
Horn perimeter	-0.341	0.926	

Significant values (p<0.05) appear in bold. Values of r_s are given below the diagonal and p-values are above it.

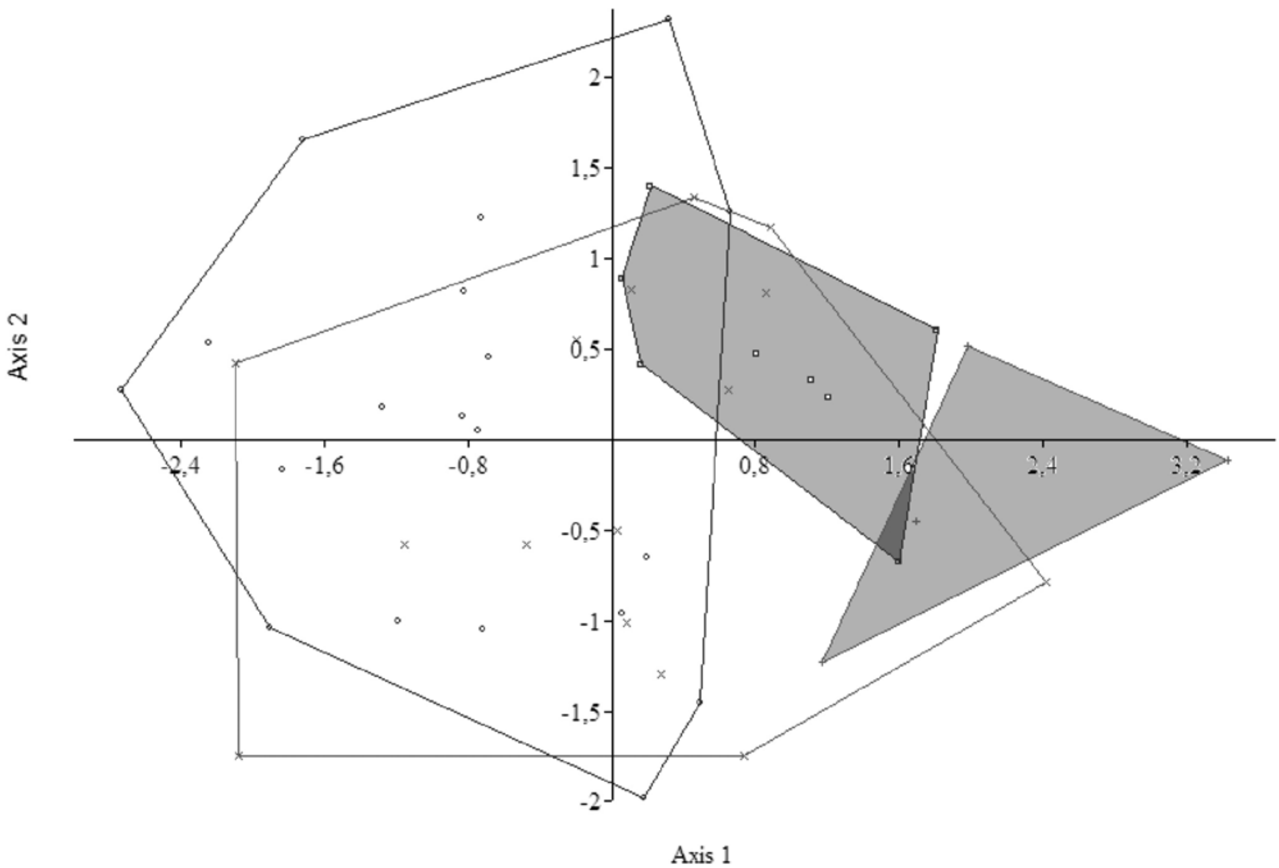

Figure 1. Canonical Variates Analysis scatter according to ear size (length and width). Grey areas include polled animals (squares for females, crosses for males), which showed a tendency towards bigger ears.

The MANOVA test showed significant differences for ear size (length and width) between horned females and polled animals (Wilk's $\lambda = 0.494$, $F_{12, 103.5} = 2.628$) (Table 3).

Table 3. One-way MANOVA comparing ear size.

	Polled males	Polled females	Horned males	Horned females
Polled males		0.2653	0.0815	0.0021
Polled females	1		0.3074	0.0032
Horned males	0.4890	1		0.2520
Horned females	0.0131	0.0192	1	

Significant differences appear in bold (Wilk's $\lambda = 0.494$, $F_{12, 103.5} = 2.628$). Hotelling's p-values are given above the diagonal, while Bonferroni corrected values (multiplied by the number of pairwise comparisons) are given below the diagonal.

Discussion

As animal mass (body weight) can be considered similar because the age range was minimal (332 ± 56 days), the index of thermoregulatory potential (which takes into account the mass of the animal) (Hoefs, 2000) was also considered to be the same. It must be highlighted that horn values are below those previously published (28.2 ± 3.97 and 16.9 ± 1.91 cm for horn length and perimeter respectively (Parés, 2006), because in this study only young animals were studied, whereas studies from 2006 used animals aged more than 2.5 years.

The heat-exchange process works by pumping blood around the 'core' of the horn —the part containing the blood vessels— as this blood passes close to the outside part of the horn, heat is lost to the atmosphere and cool blood returns to the body. Ears are also packed with capillary structures through which a sizeable quantity of blood flows (Narasimhan, 2008). So, ear vascularization would compensate for less horn surface. In fact, it appears that horn and ear surfaces of Pyrenean Brown cattle are adapted to regulate heat loss. In any case, thermoregulation in this breed would not be solely a function of having or not having horns.

This negative correlation between ear and horn surface should be investigated for other cattle breeds, especially those highly adapted to extreme environments, on the basis that ear and horn conformation are not solely ornamental structures or simply secondary traits to morphologically characterize a breed. It is now important to do research in adult animals, in which most growth has been completed. Although the sample is small, obtained results would indicate an interesting hypothesis for future studies.

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