

# The role of the horns in the thermoregulation of Murciano-Granadina dairy goats

## Introduction

The thermoregulatory function of the horns has been long debated. The combination of physiological and anatomical adaptations, as the vascular pattern of the goat's horn or the thickness of horn layers, support this hypothesis. Fourier's law of heat conduction explains how the horns temperature decreases from the base to the tip. Other studies compared late-lactation dairy goats in heat stress (HS) and thermoneutral (TN) conditions showing significant differences in dairy performances.

The objective of the current study is:

To measure the role of the horns in the response to HS of dairy goats by evaluating their thermophysiological traits and dairy performances under different ambient conditions.

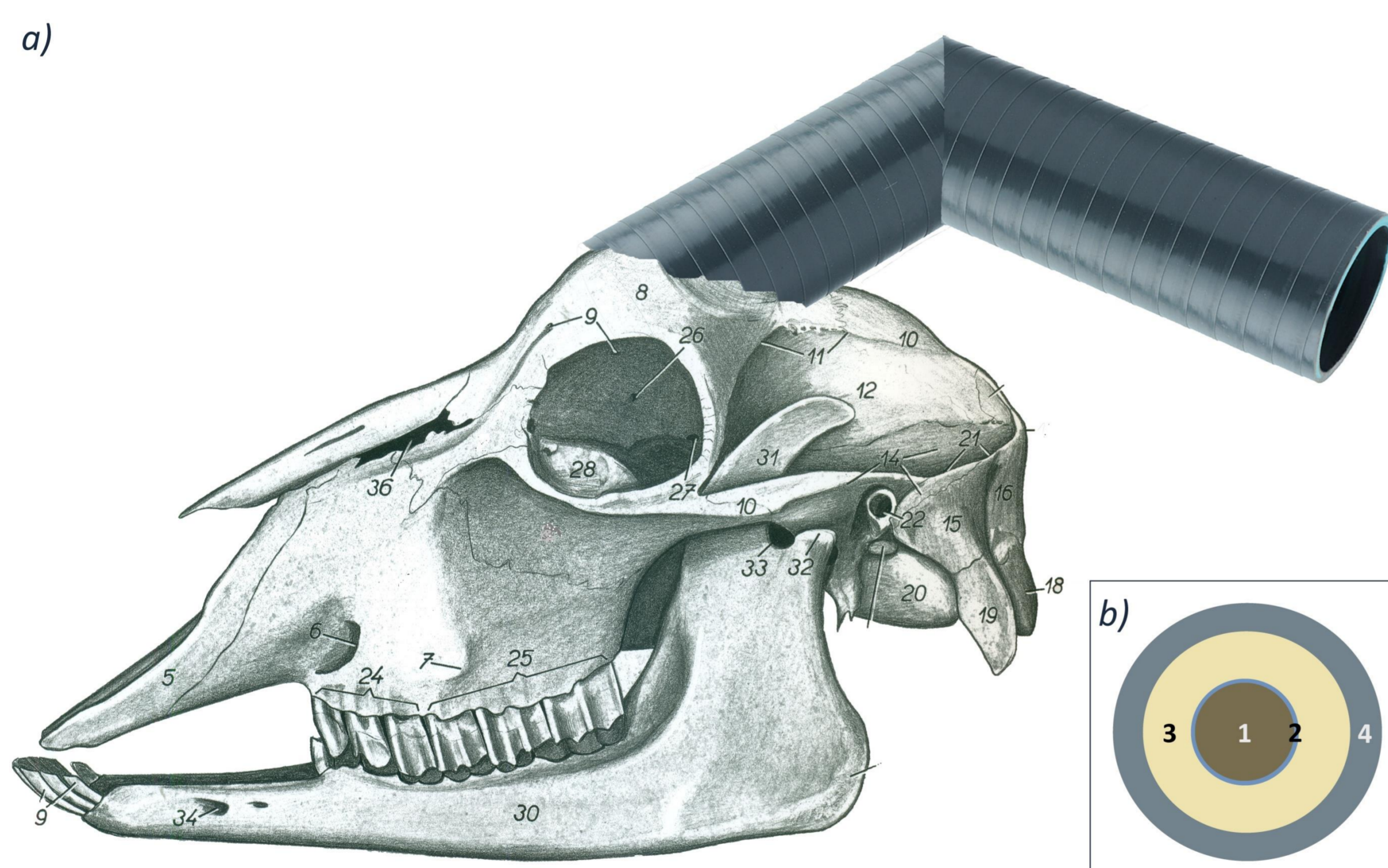
## Materials and Methods

**Animals:** 14 multiparous Murciano-Granadina dairy goats were housed in a climatic chamber and fed with a total mixed ration (forage:concentrate, 65:45) offered ad libitum.

**Heat conditions:** Does were adapted to TN for 4 d, followed by a 2 d temperature ramp and finally, kept at HS during 9 d.

**Horn treatments:** Does were separated in 2 treatments **HORN** (n = 7) and **POLL** like (n = 7). Horns were covered at d -2 and removed at d 4, as the following procedure (**Figure 1**):

- Measuring the horn length and protecting it with tape.
- Cutting the 50mm Ø polyethylene pipe in pieces and joining them with duct tape.
- Filling the horn-covering with a polyurethane foam.



**Figure 1.** Goat skull showing the horn-cover device of the POLL treatment in place (a) and its transversal section (b).

## Measurements:

- Rectal temperature (RT) and respiratory rate (RR).
- Feed intake, water consumption and milk yield.
- Body weight.
- Infrared thermography of the head using a portable camera (IRI 4010, Irisys, Northampton, UK) and its computer software (Irisys 4000 Series Imager v.1.0.0.17).

**Statistical Analysis:** Data were analyzed by period using the PROC MIXED for repeated measurements of SAS v.9.2. (SAS Institute Inc., Cary, NC). Data were tested for the normality of distribution. Means were separated using the PDIF test and significance was declared at  $P < 0.05$ .

## Results and Discussion

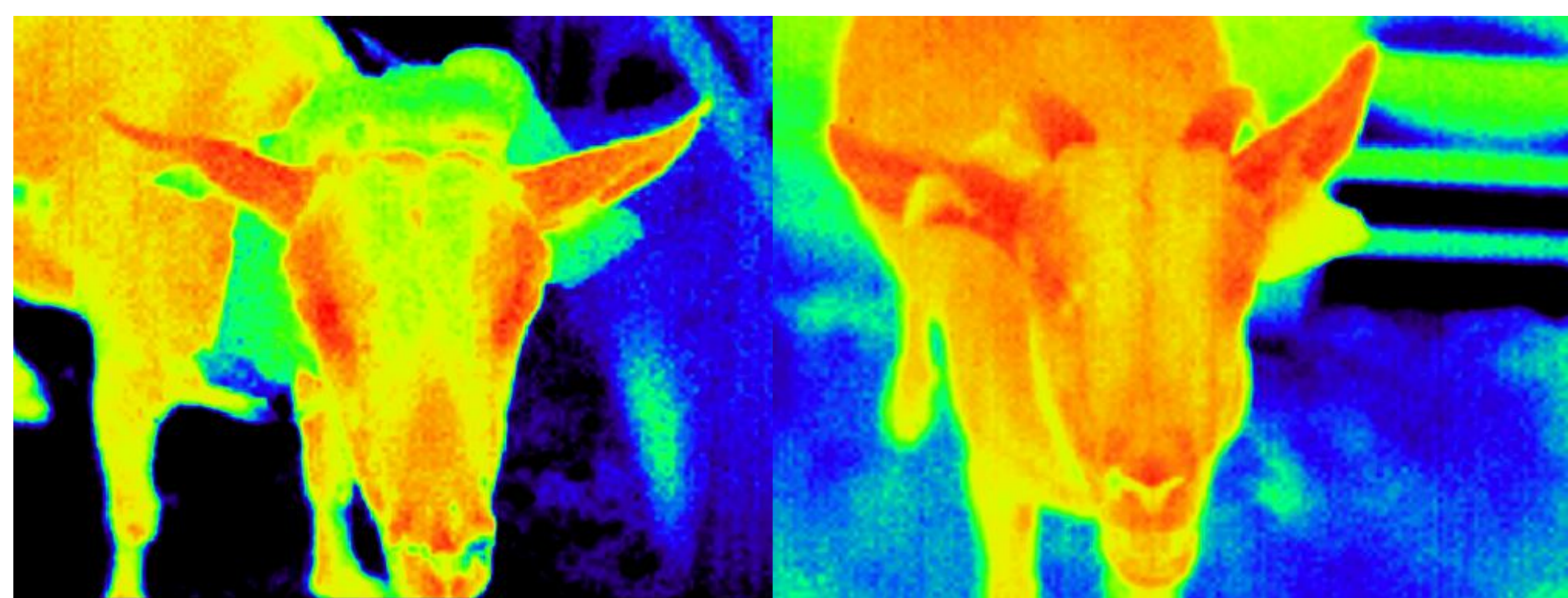
No significant differences between HORN and POLL treatments were detected in any item considered (**Table 1**).

**Thermophysiological indicators** increased in HS goats, having peaks at d 2, agreeing with other studies. The experimental day had effects on RT and RR ( $P < 0.5$ ) indicating adaptation to HS conditions.

**Water consumption** increased 54% ( $P < 0.001$ ) during HS, but contrary to what was expected, the **DM intake** did not change and the experimental day had effects on intake ( $P < 0.05$ ), as well as its interaction with the treatments ( $P < 0.01$ ).

Although **milk yield** decreased during HS, a tendency to increase with the experimental day was detected ( $P < 0.1$ ).

**Infrared thermography images (Figure 2)** made evident the effects of the ambient temperature on the surface temperatures of the head and horns of the goats, showing a decrease from the horn-base to the tip, according to the Fourier's law.



**Figure 2.** Infrared images of goats (POLL vs HORN) under HS.

**Table 1.** Thermophysiological and performance traits of lactating dairy goats according to treatments (HORN vs. POLL).

Item	P1 (d -4 to -1)			P2 (d 0 to 4)			P3 (d 5 to 10)			P-value			
	HORN	POLL	SEM	HORN	POLL	SEM	HORN	POLL	SEM	P1	P2	P3	
Feed intake, kg DM/d	1.61	1.58	0.23	1.61	1.56	0.19	1.48	1.56	0.16	0.89	0.78	0.66	
Water consumption, kg/d	4.8	4.9	0.7	4.8	4.9	0.7	9.2	8.4	1.7	0.91	0.91	0.63	
Milk yield, kg/d	1.82	1.85	0.26	1.78	1.88	0.27	1.77	1.90	0.24	0.91	0.72	0.59	
RT, °C	0800 h	38.52	38.47	0.09	38.98	38.91	0.16	39.02	38.95	0.23	0.58	0.68	0.79
	1700 h	38.90	38.91	0.12	39.74	39.67	0.17	39.84	39.88	0.24	0.87	0.70	0.87
RR, breaths/min	0800 h	35	34	3	71	72	12	85	88	15	0.86	0.93	0.86
	1700 h	36	39	3	137	135	11	156	154	11	0.25	0.90	0.81

## Conclusions

- 1) Thermophysiological traits and dairy performances analyzed under HS conditions agreed to other studies, except for DMI.
- 2) No differences between POLL and HORN goats were found in any lactational trait evaluated.
- 3) The experimental day had effects on RT and RR, as well as in DMI and milk yield, indicating that the goats adapted to HS conditions between THI = 78 and 87.
- 4) Qualitative differences between HS and TN infrared images were seen proving the Fourier's law in the horn.