Application of infra-red thermography to evaluate the influence of the fibre on body surface temperature in llamas

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SUMMARY

South American camelids may come under severe heat stress under certain climatic conditions. The influence of different shearing methods (handclipped vs machine shorn) on radiated body heat was investigated. Infrared thermography was used to measure the infrared radiation at the boundary layer of the hair coat. Removal of fleece by hand shearing resulted in little increase in surface temperature, while totally shearing by machine caused an increase of about 23% (from 26.6°C to 32.8°C). However, a critical fibre length seems to be necessary to benefit from the insulation properties of the fibre and to prevent sunburn.

INTRODUCTION

South American camelids (SAC) originate from habitats with temperature extremes ranging from about -10 to 30°C. They have been introduced to a wide variety of habitats all over the world and have shown to be able to adapt to a broad range of different climatic conditions. However, they may come under sincere heat stress when living in countries with extremely hot summers; animals died from the heat have been reported e.g. from Texas (Rotter, 1991).

Shearing of a heavily wooled animal can be used as appropriate tool for the prevention of hyperthermia in SAC (Fowler, 1989, 1994). The role of the fibre in thermoregulation in SAC, however, is not well investigated. The present study was undertaken to investigate into heat transfer on the body surface. Reported are the first experiences with the application of an infrared thermography equipment.

MATERIALS AND METHODS

The surface temperature of an animal can be measured via the radiated electromagnetic waves. The electromagnetic spectrum is divided arbitrarily into wavelength regions (bands). The thermography uses the infrared spectral band which at the short-wavelength end lies at the limit of visual perception (in the deep red) and can be divided into: the near infrared (0.75-3 µm), the middle infrared (3-6 µm), the far infrared (6-15 µm), and the extreme infrared (15-100 µm) bands.

Infrared thermography offers an excellent non-invasive tool to measure the infrared radiation on the boundary layer of animal hair coat. The technique allows the very detailed evaluation of surface temperatures with high precision (0.1°C) relating different colours (or shades of black and white) to the temperatures. The equipment performs the continuous recording by a video recorder or allows to obtain single frame shots. A scanner operating in the 8-12 µm band of the infrared spectrum was used as infrared detector, that absorbs infrared energy and converts it to a signal, e.g. electrical voltage. The signals are used by a processor to generate an infrared picture built up like a TV picture with an image resolution of 200 elements by 136 lines, resulting in 272 pixels per line.

The measurement formula is (AGEMA, 1992):

$$I_m = \underbrace{I(T_{obj}) * \tau * \varepsilon}_{\text{object radiation}} + \underbrace{\tau * (1 - \varepsilon) * I(T_{amb})}_{\text{reflected radiation from the surroundings}} + \underbrace{(1 - \tau) * I(T_{atm})}_{\text{atmospheric radiation}}$$

Where:

$I(T)$	=	Thermal value
I_m	=	Thermal value for the measured total radiation
τ	=	Efficient atmospheric transmission
ε	=	Emissivity of the object
T_{atm}	=	Atmospheric temperature
T_{amb}	=	Temperature of surroundings

For each measurement situation, the following object parameters have to be given by the operator: emissivity of the object, object distance, relative humidity, atmospheric temperature and reflected ambient temperature. In general, the values for the atmospheric and the reflected ambient temperature are considered to be the same. As no information on the emissivity of llama hair was available, the emissivity of human skin ($\varepsilon = 0.98$; AGEMA, 1992) was used in the above formula.

Seven llamas were shorn under natural climatic conditions in Germany in August 1994 with ambient temperatures ranging from 25 to 27°C. Shearing was conducted (1) by a hand clipper for sheep or (2) by an electric shearing machine. The changes in body surface temperature during the different stages of shearing were recorded by the infrared equipment in single frame shots, immediately taken after each shearing manipulation. Reported are preliminary results for two animals.

RESULTS AND DISCUSSION

In intact animals with fleece length of 15 to 20 cm high surface temperatures are seen for body parts with little or no hair cover such as the area between hind leg and belly (Fig. 1) or the head including eyes (Fig. 2)

Surface temperatures of wooled body parts were rapidly increased after removal of fleece. In Fig. 1 to 3 average surface temperatures ± standard deviations, minimun and maximum temperatures are given for selected parts of the body. Average temperatures were computed across temperatures from each pixel of the picture.

The difference in surface temperatures between animals with long hair (between 15 to 20 cm, Fig. 1, left circle) and those shorn by hand (fibre length 3 to 5 cm, Fig. 2) was found to be small (26.58°C vs 27.94°C). The largest increase was found in machine shorn animals (fibre length of 1 cm and less) with body surface temperatures raising to 32.41°C (Fig. 3) and 32.76°C (Fig. 2, right circle). Accordingly, average increases in surface temperatures were: unshorn vs hand clipped (5%), hand clipped vs machine shorn (16%), and unshorn vs machine shorn animals (23%).

Total shearing, however, does not automatically allow the SAC to thermoregulate better, because the fibre may also have an insulation value against heat (Fowler, 1989). In addition, lack of adequate protection with hair may lead to severe sunburns of the skin (A.M. Martínez Churiaque, personal communication). Apparently, there exists a critical minimum fleece length for insulation against thermal stress. The necessary fibre length for SAC, however, is still open to debate and will also depend on other characteristics of the coat, e.g., hair morphology, fibre density, coat depth, and coat weight (Gebremedhin, 1987).

For the overall consideration of thermoregulatory stress under high ambient temperatures additional factors have to be taken into consideration such as movement. Studies in Hereford cattle revealed that walking elicited greater thermoregulatory stress than the possession of a woolly hair coat (Vajrabukka and Thwaites, 1984).

Further research is needed to evaluate the long term effect of removal of fleece under different temperatures for SAC. Measurements of deep body temperature and completely dehaired skin should be included to consider the changes in the peripheral blood flow.

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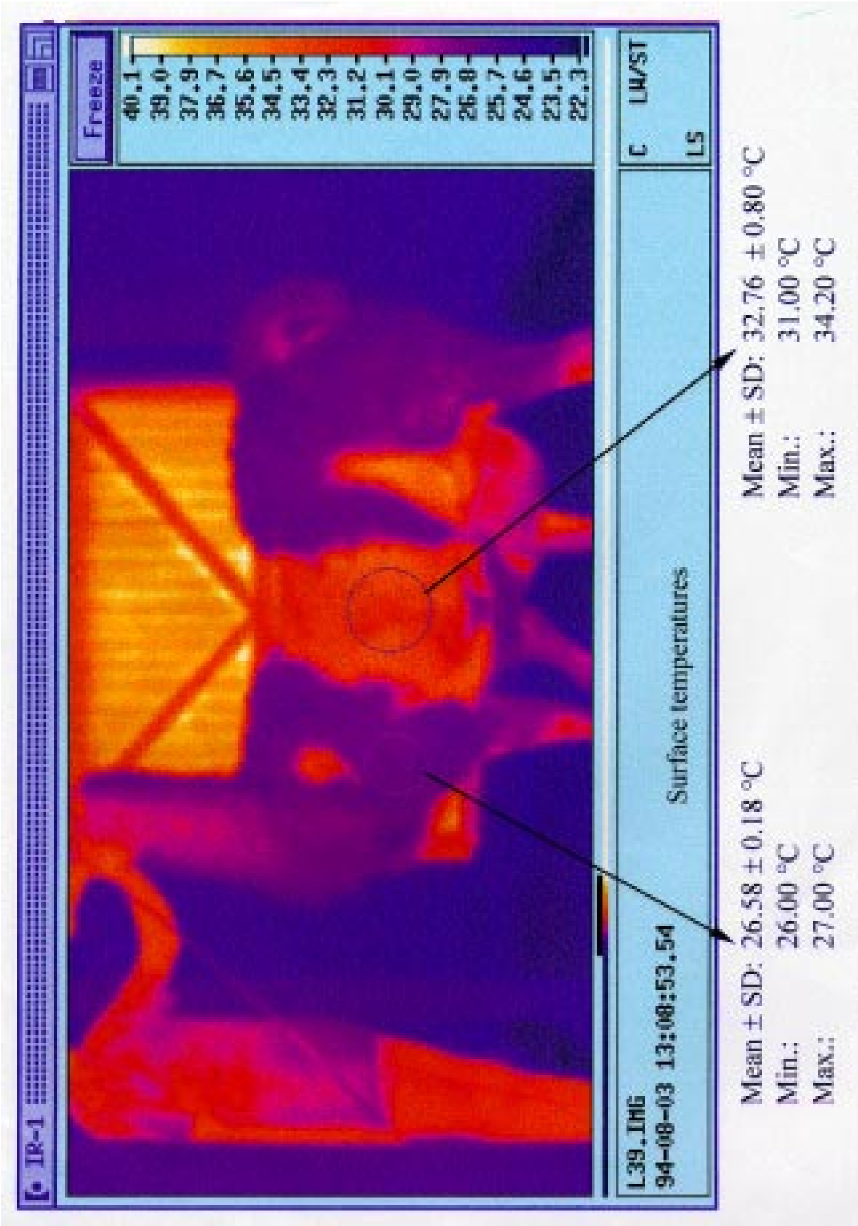

Fig. 1: Female llama (and suckling cría) with long unshorn fleece and flank shorn by machine. Left circle: long fleece (fibre length of 15-20 cm), right circle: flank shorn by machine (fibre length of 1 cm and less). Note also the small patch on the shoulder clipped by hand fibre length of 3 to 5 cm).

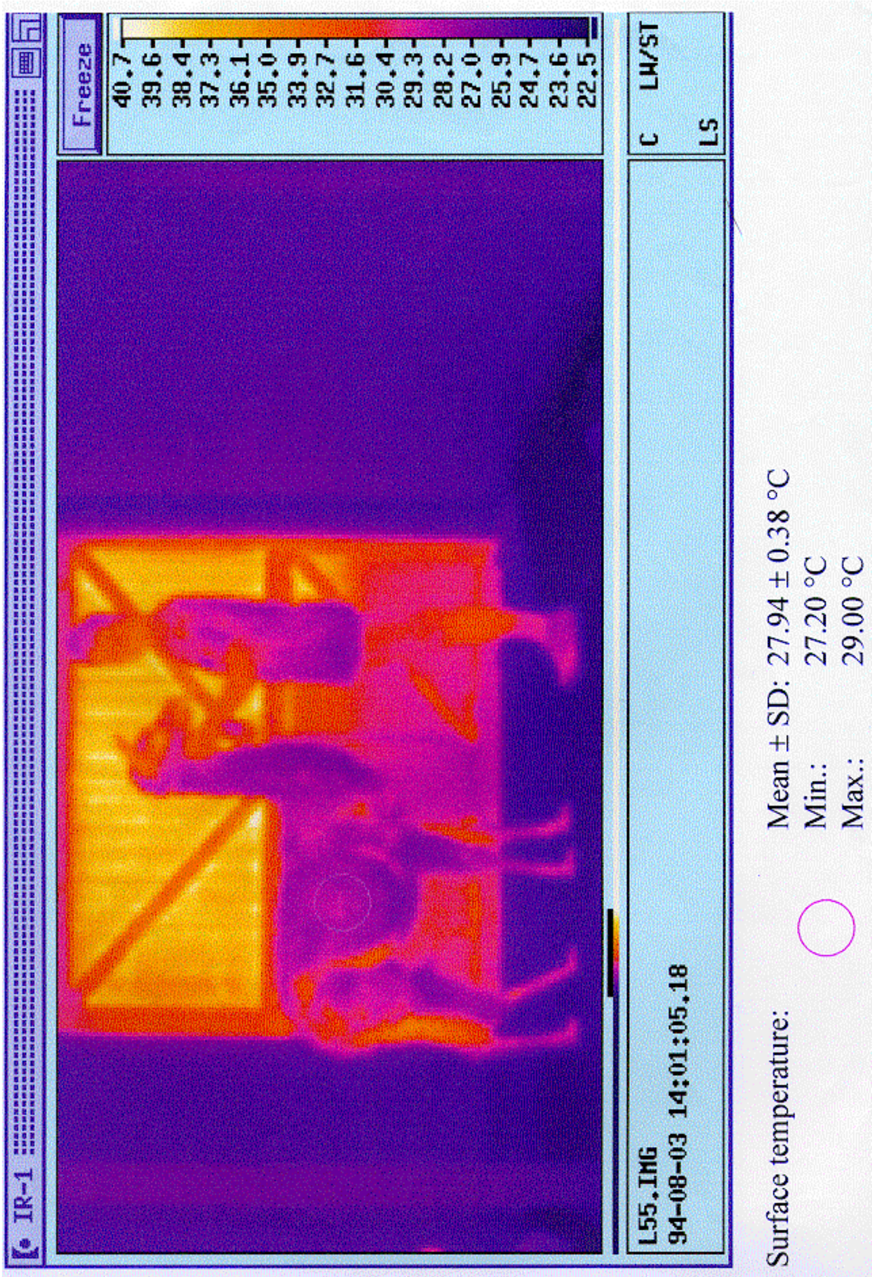

Fig. 2: Male llama with fibre completely clipped by hand (fibre length of 3 to 5 cm).

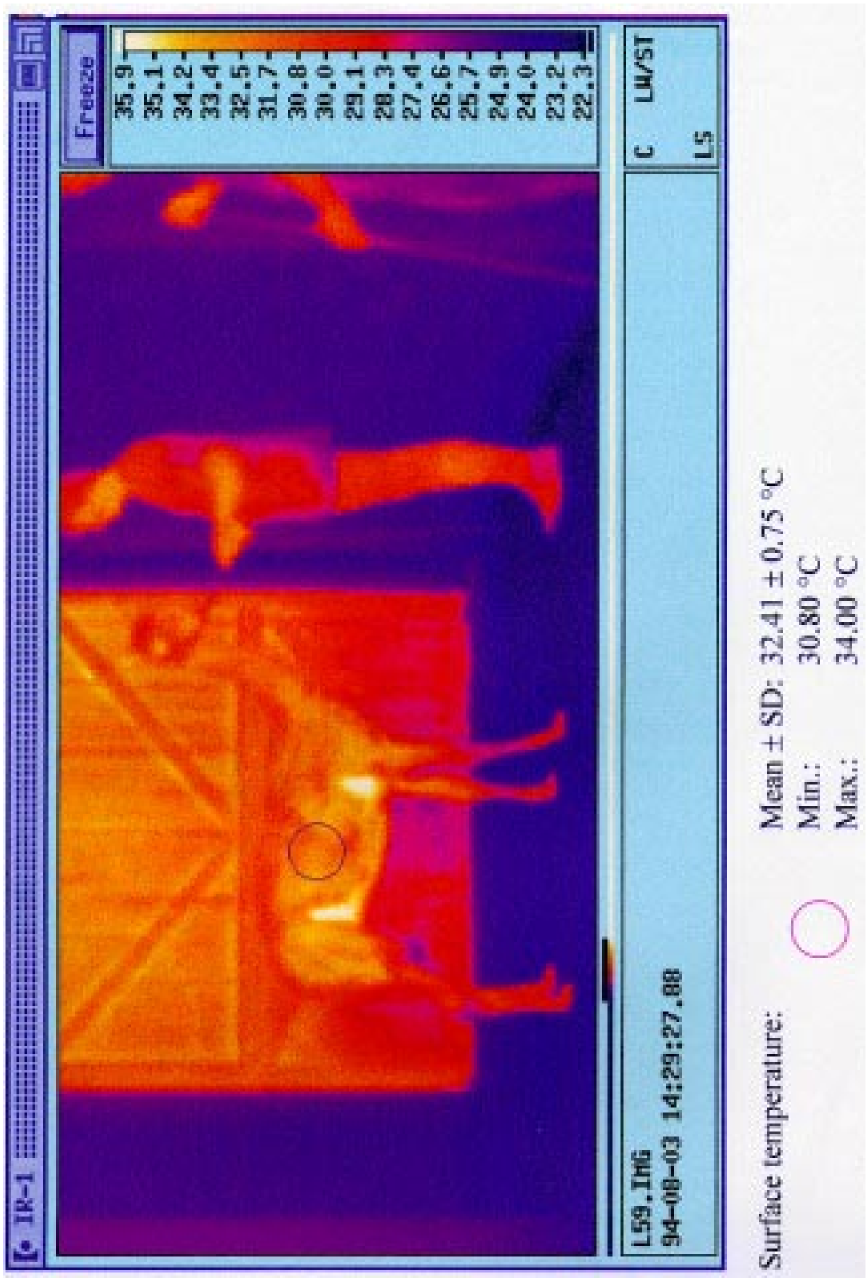

Fig. 3: The same male llama as in Fig. 2. The fibre was completely shorn by machine (fibre length of 1 cm and less).