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USE OF INFRARED THERMOGRAPHY TO ASSESS HEAT STRESS IN RABBITS

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ABSTRACT

The aim of the study was to ascertain if infrared thermography (IRT) can be used to assess heat stress in rabbits by comparing different body areas. The study was carried out during three trials in two rooms with 65 animals each. Room A was maintained at 20ºC-28ºC and room B reached values above 30ºC. In the first trial, twenty rabbits were photographed during 24 hours, every hour. In the second and the third trials, all animals of both rooms were assessed once. A thermographic camera (Fluke Ti25, Fluke Corporations, Seattle, USA) was used. The pictures were used to assess maximum and minimum temperatures in the eyes, nose, external ear and internal ear. Statistical analyses were carried out with SAS and significance was fixed at P<0.05. According to the results, eyes, nose, internal and external ear maximum and minimum temperatures are suitable to detect differences in heat stress in rabbits. Maximum eye temperature show a lower range of variation in comparison to other body areas and there were found difficulties in taking a good internal ear picture. Minimum eyes and maximum or minimum nose temperatures are suggested to assess heat stress in rabbits. IRT can be used to assess differences in thermal stress of animals in the same or different buildings.

Key words: Animal welfare, heat stress, infrared thermography, rabbit,

INTRODUCTION

Stress has been defined as a state that occurs when an animal is required to make abnormal or extreme adjustments in either its physiology or behaviour in order to cope with adverse aspects of its environment and management (Fraser et al 1975). Rabbits are homoeothermic animals and they are very sensitive to high temperatures since they have few functional sweat glands, limiting they ability to eliminate excess body heat when the environmental temperature is high. In conditions of high temperatures, the animals react with physiologic and behaviour changes (Baêta et al 1998). The specific regions where blood flow changes have been recorded as species specific (Stewart et al 2007). These changes can be detected by infrared thermography (IRT) as a temperature change (Stewart et al 2005). The technique of IRT has been applied successfully in ruminants (Stewart et al 2005) and rabbits (Ludwig et al 2007). The method consists in a camera that measures the electromagnetic radiated energy from a body. Different temperatures emit different frequencies of waves, these small changes being detected very accurately using IRT (Stewart et al 2005). The aim of this study is to ascertain if IRT can be used to assess heat stress in does and bucks when the cause is a temperature above the thermoneutral zone of rabbits reared in typical commercial conditions. The objective was also to compare the use of different body areas and to assess differences between animals allocated in different positions into a same room.

MATERIAL AND METHODS

The experiment was carried out from May to July 2010 at a experimental farm of IRTA in Spain during three trials separated between them in 20 days. Two identical closed buildings with ventilation and heating systems housed a total of one hundred and thirty commercial rabbits (65 in room A and 65 in room B; Caldes line). In room A there were 23 breeding males and 42 breeding females. In room B there were 22 breeding males and 43 breeding females. Room A was maintained during the whole day around 20ºC-28ºC, while room B was heated during 6 hours a day to values above 30ºC, (Fig. 1). The temperature was automatically recorded every 30 min in a data logger (Tinytag, Gemini Data Loggers, Chichester, United Kingdom). In both cases, the relative humidity was maintained between 50 and 65%. Females were housed in a single cage (100×42×38 cm) equipped with a plastic footrest, a feeder, nipple drinker and a nest box. Males were housed in a single cage (85x40x30 cm) equipped with a plastic footrest, a feeder and nipple drinker. Animals were fed ad libitum with an all-mash pellet (15.5% CP, 18.7% CF, 3.8% EE and 8.5% ash) and water ad libitum. Does had a minimum age of 90 days and a maximum of 250 days. Bucks had a minimum age of 150 days and a maximum of 270 days. The animals were photographed into the cage with 50 centimetres of distance to the animal by means of the thermographic camera (Fluke Ti25, Fluke Corporations, Seattle, USA) avoiding any physical contact (Fig. 2). The camera have a thermal sensitivity of 0.05ºC at 30ºC target temperature and a spatial resolution of 1.25 mRad.

In the first trial, twenty rabbits (12 females and 8 males) were photographed by the thermographic camera during 24 hours, every hour, to assess the circadian cycle (from 09.00 hours of day 1 to 08.00 hours of day 2) in both rooms. The pictures consisted in taking the face of the animals to assess maximum and minimum temperatures in the eyes and nose. In some cases, more than one picture was necessary. The gender of the animal was considered. In the second and the third trials, all animals of both rooms (65 per room) were assessed between 10.00 and 12.00h. The pictures consisted in taking the face and the head of the animals to assess maximum and minimum temperatures in the eyes, nose, external ear and internal ear. The gender of the animal and its position into the room (a total of 9) was considered (Figure 3). In each position there was from 5 to 10 cages (rabbits**)**. The images were analyzed with the *Smartview 3.1* software (Fluke Corporation, 2006-2010). The eyes, the ears (externally and internally) and the nose were manually marked on the image and the software measured minimum, mean and maximum temperatures in the selected area. In the present study only maximum and minimum temperatures were considered.

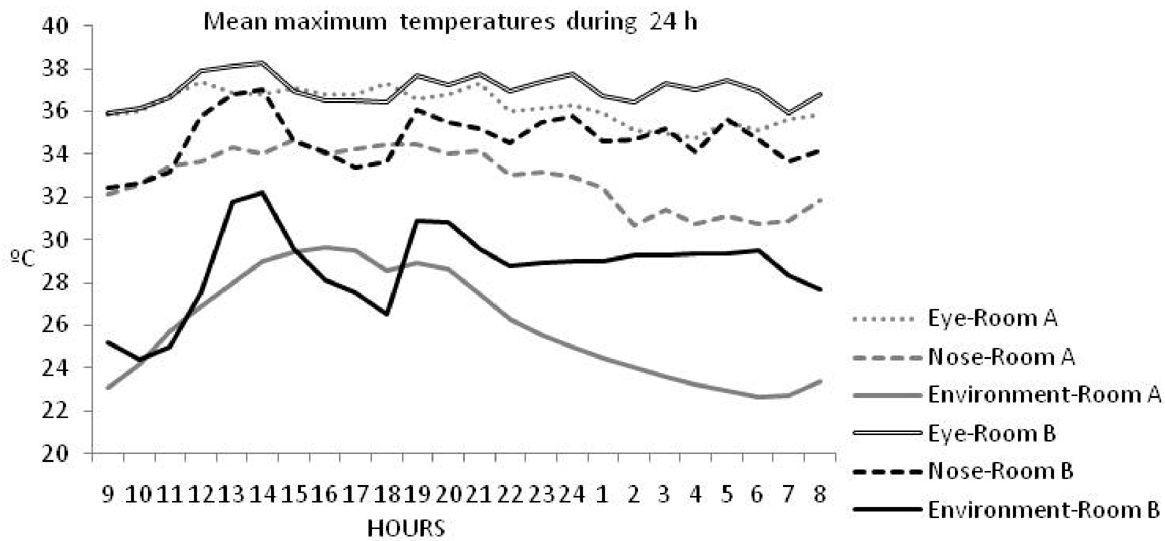

Figure 1. Environmental temperatures in rooms A and B from 09.00h to 08.00(+1d). Mean maximum temperatures found in trial 1 in rabbit's eyes and nose in rooms A and B.

Statistical analysis

Data were analyzed separately by each one of the three trials the Proc Mixed procedure of SAS (software SAS Institute Inc. 2002-2008). In trial 1, animal was included in the analyses as a random effect and repeated measure. The dependent variables were: maximum and minimum eye and nose temperature. The independent variables considered were: room (A vs B), hour (from 09.00 to 08.00(+1d)) gender (male vs female), the interaction room*gender and the interaction room*hour. In trials 2 and 3, animals were included in the model as a random effect. The dependent variables were:

maximum and minimum eye, nose, external ear and internal ear temperature. The independent variables considered were: room (A vs B), gender (male vs female) and the interaction room*gender. In addition, for each one of the rooms separately, the position of the animals (from 1 to 9) was also studied in a separate model for each dependent variable. In all cases, the accepted significance level was $P<0.05$.

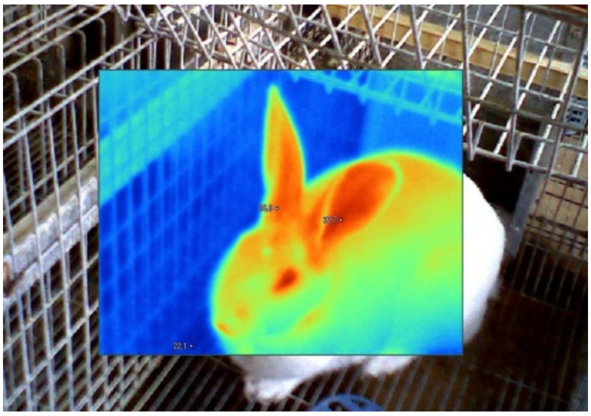

Figure 2. Thermographic image of a rabbit in the cage

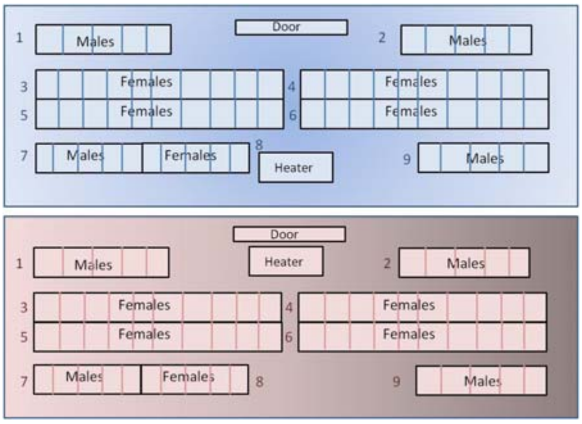

Figure 3. Position of the rabbits in each room

RESULTS AND DISCUSSION

Trial 1

In Figure 1 is shown the maximum temperature registered for 24 hours in rabbit's eyes and nose allocated in rooms A and B. The mean temperatures in the room A and B during trial 1 were 25.45 and 28.64 ºC, respectively. A room effect (P<0.0001), hour effect (P<0.001) and room*hour interaction (P<0.0001) was found for the maximum temperatures registered in eyes. The mean maximum temperatures ± SE registered in eyes during trial 1 in room A and B were 36.24±0.073 and 37.03±0.088, respectively. Differences between rooms were specifically found at 03.00, 04.00, 05.00, 06.00 and 08.00h. A room effect (P<0.0001), hour effect (P<0.001) and room*hour interaction (P<0.0001) was also found for maximum temperatures registered in nose. The mean maximum temperatures ± SE registered in nose during trial 1 in room A and B were 32.89±0.057 and 34.73±0.076, respectively. Differences between rooms were specifically found at 12.00, 13.00, 14.00, 19.00, 20.00, 24.00, 01.00, 02.00, 03.00, 04.00, 05.00, 06.00, 07.00 and 08.00h.

Trial 2 and 3

In Figure 4 are shown the mean maximum temperatures registered in rooms A and B during trial 2 and 3 in eyes, nose, internal ear and external ear. Mean temperature in room A at the time of observation was 28 and 30ºC in trials 2 and 3, respectively. Mean temperature in room B at the time of observation was 32 and 34ºC in trials 2 and 3, respectively. A room effect was found for maximum temperatures in eyes (P<0.0001), nose (P<0.0001), internal ear (P<0.0001) and external ear (P<0.0001). A room effect was also found for minimum temperatures in eyes (P<0.0001), nose (P<0.0001), internal ear (P<0.0001) and external ear (P<0.0001). In trial 2, it was found a gender effect in the maximum and minimum temperatures registered in nose (P<0.01), with does showing the highest values. In addition, also in trial 2, a gender*room effect was found for minimum temperature in eyes (P=0.0252), does from room B showing higher temperatures than bucks from the same room, and maximum and minimum temperatures in internal ear (P<0.05), does from room A showing lower temperatures than bucks from the same room.

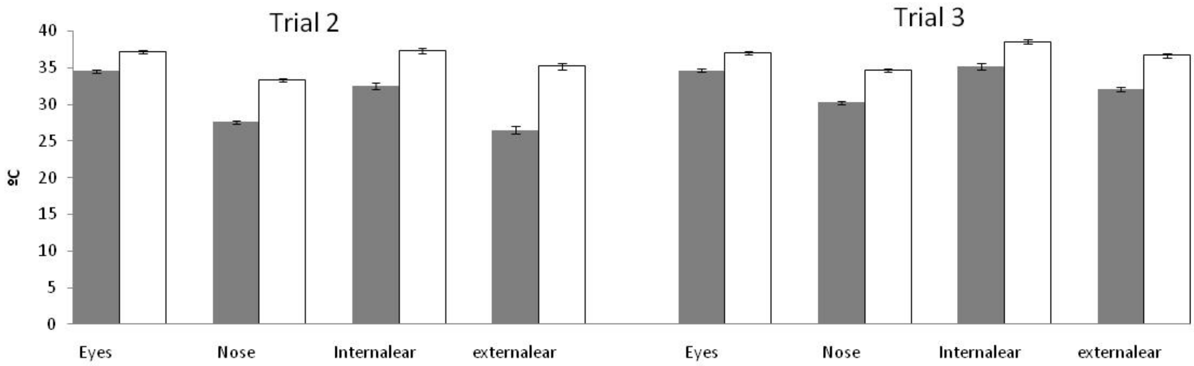

Figure 4. Mean maximum temperatures ± SE found in trial 2 and 3 in rabbit's eyes, nose, internal ear and external ear in rooms A (in grey) and B (in white). In all cases, differences are significant at $P<0.001$

When the position of the animals in the rooms was considered (Fig. 3), it was found a position effect for maximum temperature in eyes in both rooms and both trials ($P<0.05$). For minimum temperature in eyes a position effect was only found in room B for trial 2 ($P<0.0001$) and room A for trial 3 ($P=0.0442$). In trial 2, a position effect for maximum temperature in nose was found in both rooms ($P<0.05$), but only for room A in trial 3 ($P=0.0064$). For minimum temperature in nose a position effect was only found in both rooms of trial 2 ($P<0.05$). In trial 2, a position effect was also found in room A for maximum temperature in the internal ear ($P=0.0147$) and in room B for minimum temperature in the internal ear ($P=0.0174$). In trial 3, a position effect was found in room B for maximum and minimum temperature in the internal ear ($P<0.01$) and maximum and minimum temperature in the external ear ($P<0.01$). In general, the highest temperatures were found in position 7 and the minimum in positions 2, 4 and 6 in room A. In room B, the highest temperatures in eyes and nose were found in positions 3 and 6 and the minimum in position 7 (Figure 2).

DISCUSSION

All the body areas used in the present study to assess thermal stress in rabbits gave statistical differences between rooms, although clear differences can be seen between them. It is easy to see in Figure 1 that although the temperature in eyes and nose follows the circadian cycle established in both rooms, the range of temperatures along the day is higher in the case of the nose in comparison to the eyes. As the standard error of both areas is very similar, this different range can explain why in the case of eyes there were found differences in maximum temperatures between rooms in 5 of the 24 hours analysed and in the case of nose in 14 of the 24 hours. Another point to state from trial 1 is about the curves of temperature registered in eyes and nose in room B (where animals were subjected to the highest temperatures), in which a sawteeth form can be observed in comparison to the room A, especially from 20.00 to 08.00h. This could be considered a sign of thermal stress as it seems that is more difficult for animals to maintain a regular heat loss. The difference in temperature between rooms A and B at the moment of observation in trials 2 and 3 was of 4ºC. However, in all the body areas assessed, the maximum difference encountered between animals from both rooms was higher than the difference in the environmental temperature. In all cases, these maximum differences were found in trial 2, in which room B was clearly maintained under severe heat stress conditions (35ºC). Therefore, it could be concluded that with a same difference in temperature in terms of degrees, the differences between animals will be higher as highest is the maximum temperature.

The highest temperatures found in the present study were for eyes, followed by internal ear, external ear and finally, nose. Eyes temperatures have been used as stress indicators in other studies (Schaefer et al 2003; Cook et al 2005; Stewart et al 2005), but we did not find in the literature their use in heat stress conditions or the interference that high temperatures can have in the assessment of other stress factors. In addition, other good indicators would be the maximum and minimum nose temperatures. Caputa et al (1976), found that the nose had the function of a thermolytic organ in rabbits. Although Nakayama et al (2005) found that the nasal temperature decrease significantly when monkeys are in negative emotional state, this has not been studied in rabbits, so further research is needed. Finally, the differences found among positions into the room in trials 2 and 3 allow to infer that IRT can be a good tool to detect areas in the buildings in which animals are subjected to higher mean temperatures than those given by sensors.

CONCLUSION

IRT is a good tool to assess thermoregulation in rabbits, especially when eyes and nose is used. However, nose provides a major range of difference than eyes. IRT allows to assess areas in buildings in which animals can be subjected to higher thermal stress. IRT can be used in the future to detect thermal stress in specific animals, to detect problematic zones in a building and to decide the best place to allocate thermal sensors for the general thermoregulation devices of the farm.

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