Archivos de Zootecnia
Journal website: https://www.uco.es/ucopress/az/index.php/az/
SHORT NOTE

Acute heat stress compromises the physiology of growing pigs

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Additional keywords

Adaptation.
Environment.
Homeothermy.
Hyperthermia.
Temperature.

SUMMARY

Twenty-four castrated male pigs were used to determine the effect of ambient temperature on thermoregulatory responses during an acute heat stress test conducted for 48 hours. The animals were housed in two climatic chambers with controlled temperature, humidity and ventilation. The animals were maintained in thermal comfort for the category (22°C) in one of the chambers, and in the other, under heat stress (34°C). Twelve pigs were housed in each chamber, with the experimental unit composed of two animals in the stall, totaling six replicates. The environmental conditions of the climatic chambers and physiological parameters of respiratory rate and rectal and surface temperature were monitored at the beginning of the experiment and every 12 hours during the experimental period. Growing pigs presented effective thermoregulatory responses beginning at 12 hours under acute heat stress (34°C).

O estresse térmico agudo compromete a fisiologia dos suínos em crescimento

RESUMO

Foram utilizados 24 suínos machos castrados com o objetivo de determinar o efeito da temperatura ambiente sobre suas respostas termorreguladoras durante o estresse agudo por calor durante 48 horas. Os animais foram alojados em duas câmaras climatizadas com controle de temperatura, umidade e ventilação. Em uma das câmaras, os animais estavam em conforto térmico para a categoria (22°C) e em outra, em estresse por calor (34°C). Em cada câmara foram alojados 12 suínos, sendo a parcela experimental representada por dois animais na baia, totalizando seis repetições. As condições ambientais das câmaras climáticas e os parâmetros fisiológicos de frequência respiratória, temperatura retal e superficial foram monitoradas no início e a cada 12 horas durante o período experimental. No período observado, suínos em crescimento apresentaram respostas termorregulatórias efetivas a partir de 12 horas de exposição ao estresse agudo de calor (34°C).

Palavras chave adicionais

Adaptação.
Ambiente.
Homeotermia.
Hipertermia.
Temperatura.

Information

Cronología del artículo.
Recibido/Received: 22.12.2017
Aceptado/Accepted: 29.03.2019
On-line: 07.04.2019
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INTRODUCTION

In tropical climate regions, pigs are subjected to the negative effects of heat stress, with their growth and termination phases being the most impaired due to their high thermogenesis. Global climate change predictions project an increase in ambient temperature over the years (Yan et al., 2016), leading tolikely increases in stress-related heat problems in animal production activities. Heat-stressed pigs activate mechanisms to prevent or mitigate cell damage and protect vital organs. However, there is evidence of a two-phase heat acclimatization pattern. During the first, pigs undergo an adaptation phase characterized by rapid changes, including changes in respiratory and heart rates (Renaudeau et al., 2010). The second phase is characterized by an increase in rectal temperature during the first 24 hours of exposure, with a gradual decrease during the following days (Renaudeau et al., 2007), where heat dissipation through respiration becomes more efficient. Studies that evaluate acute heat stress effects on physiological parameters in pigs may contribute to indicate new management possibilities in order to assist in the adaptive process of the animals to their thermal environment, avoiding damages related to temperature fluctuations in the installations. In this context, this study aimed to evaluate the physiological responses of growing pigs maintained under acute heat stress.

MATERIAL AND METHODS

All experimental procedures were approved by the Federal University of Lavras Animal Use Ethics Committee (protocol 059/14). Twenty-four castrated male pigs of a commercial lineage, with initial weight of 30.5 ± 0.6 kg and mean age of 77 ± 2 days, were housed in two air-conditioned chambers maintained at 22 °C and 34 °C, respectively comfort and heat conditions. Twelve pigs were housed in each chamber, with the experimental unit composed of two animals in the bay, in a completely randomized design. Each chamber was composed of six experimental bays with concrete floors, totaling an area of 3.45 m^2 equipped with semi-automatic feeders and drinking fountains of the pacifier type. The experimental period lasted 48 hours. The environmental conditions of the climatic chambers were monitored throughout the experimental period by a digital thermohygrometer (Incotherm, Model 7666.02.0.00) comprising an internal sensor and an external sensor coupled to a black globe. The equipment were kept at half height of the animal's bodies and readings were performed every 12 hours. The experimental diet was formulated with corn and soybean meal, supplemented with vitamins and minerals, according to recommendations reported by Rostagno et al. (2011). The animals received water and feed at will during the experimental period. The physiological parameters of respiratory rate and superficial temperature were calculated according to the average temperature of the palette, shank, neck and ear base and rectal temperature every 12 hours. The respiration rate was determined by counting the flank movements of each animal per minute. A thermometer (Model GM320, Benetech) was used for measuring surface temperature, with readings performed at 20 cm from the animals. A digital clinical thermometer was used to measure rectal temperature. Statistical analyses were performed with the SAS statistical package (9.0). The data were submitted to the Shapiro-Wilk test at a 5% probability level to verify data normality. Data non-normally distributed, when possible, were normalized by the PROC RANK procedure of the same statistical package and the non-normal data were compared by the Kruskal-Wallis test at a 5% level. Normally distributeddata were submitted to an analysis of variance. The physiological parameters were estimated by means of linear and quadratic regression analyses, according to the data adjustment. The unadjusted data were compared by the Tukey test at a 5% probability level.

RESULTS

The values of air temperature (°C), relative humidity (%) and globe temperature index and humidity in the thermal comfort conditions were, respectively: 22.4 ± 0.1; 81.6 ± 2.9 and 70.0 ± 1.3. In the heat conditions, they were, respectively: 34.4

Table I. Physiological parameters of growing pigs during the first 48 hours of the experiment (Parâmetros fisiológicos de suínos em crescimento durante as primeiras 48 horas do experimento)

Treatment	Time					P hour	CV (%)
	0	12	24	36	48		
Respiratory frequency (mov x min^{-1})							
Comfort	28.0 B	30.4 B	40.0 AB	54.0 A	57.3 A	<0.001	16.90
Heat	27.2 B	126.7 A	132.0 A	92.8 AB	130.7 A	<0.001	47.64
P treat	0.798	<0.001	0.001	0.044	0.001		
CV (%)	19.51	68.13	56.88	46.01	48.06		
Rectal temperature (°C)							
Comfort	37.9	38.5	39.1	39.1	38.6	0.246	2.21
Heat	37.9 B	40.2 A	39.7 AB	39.7 AB	39.7 AB	0.003	2.70
P treat	0.853	0.002	0.014	0.014	0.002		
CV (%)	3.21	2.82	1.13	1.22	1.78		
Surface temperature (°C)							
Comfort	31.5 C	34.0 B	34.3 B	36.0 A	33.9 B	<0.001	5.75
Heat	31.5 D	39.7 B	35.6 C	36.0 C	41.8 A	<0.001	10.21
P treat	0.987	<0.001	<0.001	0.379	<0.001		
CV (%)	2.79	8.73	3.19	3.39	11.48		

The letters differ in each line by Tukey's test at a 5% probability level.

± 0.7; 77.3 ± 3.7 and 89.0 ± 1.2. The animals maintained in the heat conditions showed an increase in respiratory rate estimated by the following equation:

.There was no linear or quadratic adjustment (P> 0.05) for the respiratory rate of the animals in the comfort conditions. Except for zero hour, the animals kept under the heat conditions presented higher respiratory rate (P <0.05) than those maintained in thermal comfort. The observed increases were of 416.78%; 330.0%; 171.85% and 228.10% respectively for hours 12, 24, 36 and 48. The animals kept in thermal comfort did not display alterations (P> 0.05) in rectal temperature. However, those maintained in heat conditions showed an increase (P <0.05) in this variable of 4.42%; 1.53%; 1.53% and 2.85% respectively at 12, 24, 36 and 48 hours (**Table I**). The rectal temperature of the animals maintained under the heat conditions was estimated by the following equation:

Exposure to heat resulted in an increase (P <0.05) of animal surface temperature, higher at hour 12, when an increase of 26.03% was observed. However, the model was adjusted only for the animals maintained in thermal comfort, according to the following equation:

DISCUSSION

According to Manno et al. (2006), the increase in respiratory rate of heat-reared pigs can be considered one of the first physiological adjustments to maintain thermoregulation. When the ambient temperature approaches 30 °C, sensitive heat exchanges are reduced and latent heat exchange (evaporation through the respiratory tract) prevails, accounting for up to 60% of pig heat dissipation, which may increase the respiratory rate by up to 100%. The increase in the rectal temperature of the animals maintained at 34 °C can be explained as being the result of the difficulty encountered by the pigs in maintaining homeothermia at temperatures above their thermal comfort zone. It is worth mentioning that elevations were observed early during the exposure, similar to the results reported by Renaudeau et al. (2010) and Kierf et al. (2009) who also evaluated physiological parameters and observed a significant increase in respiratory rate and rectal temperature. The elevation of the surface temperature observed in the pigs kept under heat conditions can be justified as a consequence of the increase in ambient temperature, since the measurements were carried out on the skin surface. The increase of the heat load in the environment may have promoted higher thermal radiation to the surface of the animals, who were not efficient in dissipating it, since sensitive mechanisms become inefficient due to the low thermal gradient for thermolysis. According to ASHRAE (2001), when feeling thermal discomfort, the first physiological mechanism to be activated is vasomotor regulation (vasodilation or vasoconstriction), reducing or increasing thermal skin resistance, similar results were reported by Manno et al. (2006), who observed higher surface temperature in pigs in the growth phase maintained under heat conditions. In the present study, rectal temperature was considered the most significant criterion for assessing heat tolerance, because it indicates the homeothermia maintenance efficiency during heat stress. Mechanisms that increase heat dissipation failed to fully compensate for the excessive heat load, which may explain the rapid increase in rectal temperature during the first twelve hours of exposure.

CONCLUSIONS

During the observed period, growing pigs presented effective thermoregulatory responses after 12 hours of exposure to acute heat stress (34 °C).

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