Livestock Science 151 (2013) 29–34

Contents lists available at SciVerse ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Heat stress assessment by swine related vocalizations

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ARTICLE INFO

Article history:
Received 2 July 2012
Received in revised form
15 October 2012
Accepted 16 October 2012

Keywords:
Heat waves
Heat stress
Physiology
Sound analysis
Vocalisations

ABSTRACT

In intensive swine farms, stressful conditions in the climate, namely heat stress, affect animal behaviour and welfare. Pigs reared in commercial fattening housing suffer from temperature increases and from their inability to get free to refresh themselves any time they need to. The closed and dense environment further worsens this condition.

This particular study was conducted to determine whether heat stress induces specific vocalisations in a group of piglets bred in standard intensive conditions and whether these vocalizations are acoustically different from other swine normal vocalizations. The temperature increase was aimed to stimulate heat-stress-specific behaviours and vocalisations. For this purpose, the vocal calls were coupled with environmental and physiological parameters (rectal temperature and respiration rate) collected during the temperature-increasing tests.

The study of sound acoustic features such as frequency, duration and amplitude, together with the analysis of the environmental parameters, showed a clear difference between heat-stress-related sounds and other types of vocal calls recorded while the piglets were not stressed by environmental insults. This result shows how animals can communicate emitting specific calls and provides a deeper knowledge of animal behaviour, thereby providing a means toward better animal welfare.

1. Introduction

Heat stress is widely recognised as a stressful condition that affects animal behaviour, animal welfare and production quality.

Intensive modern swine farming deals with animals under extreme climate conditions because of the closed environment, the poor indoor air quality, the use of concrete floors that cannot absorb manure and the deep pits for manure stocking that release gaseous ammonia from underneath (Wathes et al., 2012). The effect of high temperature on pig growth performance and health has been extensively studied and published (Close, 1981; Hillmann et al., 2004; Patience et al., 2005). In most of the published studies on the effect of thermal stress on pig performance, the animal-related measurements were performed with a prior adaptation from 4 to 20 days to the experimental temperature (Renaudeau et al., 2008).

However, during real summer heat waves, especially in temperate climates, pigs are suddenly exposed to high temperatures with negative consequences on their health and their performance (Nienaber and Hahn, 2007). Short-term, high-intensity hot weather patterns are referred to as heat waves.

The physiological responses of pigs have been studied intensively, and the RR and RT have been shown to predictably increase with rising temperature (Brown-Brandl et al., 1998; Liao and Veum, 1994). Because pigs do not sweat, they rely heavily on evaporative losses via the respiratory tract for cooling. Animal mortality has also been related to a certain extent with this phenomenon. Short-term adaptive changes related to behavioural, physiological and immunological functions are the initial

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http://dx.doi.org/10.1016/j.livsci.2012.10.013

responses to acute events, whereas longer-term challenges induce performance-oriented responses. Generally, pigs respond to high ambient temperature by nutritional and physiological adaptation to maintain homoeostasis; above the upper limit of the thermo-neutral zone (approximately 29 °C for weaned pigs), an increase in temperature results in a decrease in the average daily feed intake to limit heat production and an increase in the respiratory rate to remove the excess heat (Fuquay, 1981; Kamada and Notsuki, 1987). In addition to the physiological body responses, behavioural reactions to distress include animal vocalisations. Past studies have shown that pigs respond to pain or distress with specific vocalisations, in terms of acoustic parameters e.g. frequency, and that these responses might be used to assess animal welfare in intensive farming conditions (Manteuffel et al., 2004; Marx et al., 2003; Schön et al., 2001; White et al., 1995). Vocal responses are shown to be strictly associated with specific stimuli according to phylogenetic evolution. Animal welfare studies, together with microclimate improvement, must take into account the animals' responses to the severe environment to which they are exposed. Understanding these responses and observing and recognising animals in distress is especially important for implementing appropriate practices to reduce the effects of stress.

A possible means to approach this goal is derived from sound analysis, including the continuous recording and automatic processing of animal sounds, in livestock farming compartments as a tool for the early detection of disease and distress. The strength of this technique is its non-invasiveness and the possibility to work on-line to continuously monitor the animals. The capabilities of such a system, based on the classification algorithms, have been tested in previous studies investigating respiratory diseases (Exadaktylos et al., 2008) or animal welfare (Schön et al., 2004). The aim is to increase our understanding of animal vocalizations and welfare by studying their responses to typical stressful conditions. This particular study was conducted to determine whether heat stress induces specific vocalisations in a group of piglets bred in standard intensive conditions. For this purpose, the vocal calls were coupled with environmental and physiological parameters collected during the temperature-increasing tests.

2. Materials and methods

Heat stress trials were performed at the experimental farm "Centro Zootecnico Didattico Sperimentale" of the Milan Veterinary facility in Lodi (Mi). The experiment utilised litter mates of crossbred (Large White × Landrace) females and males with an average initial live weight of 4.92 ± 0.35 kg. The piglets were observed for 120 days from their age of about 25 days. The piglets were housed in a mechanically ventilated building in two adjacent pens of 2×2.5 m^2 dimensions and the floor was constructed from fully slatted PVC. The piglets were fed a pelleted diet, formulated to meet or exceed NRC (1998) recommendations for all nutrients, twice a day, and water was available ad libitum. Each piglet's weight was measured, using an industrial livestock scale, at their arrival in the experimental facility, during the period of the heat stress trials and at the end of the experimental trials. A total of 20 piglets were housed in groups of ten per box for the first month of the trial. The groups were then split into three smaller groups of 7, 7 and 6 animals. This allowed a space allowance from 0.2 m^2 to 0.3 m^2 as per the CEE/88/2001 requirements.

The room temperature was adjusted for the thermal comfort zone of the weaned piglets, ranging from 32.2 °C when the animals were 4.92 ± 0.35 kg to 25.2 °C in the last week of the trials. The relative humidity ranged from 20% to 30%, and the ventilation rate was 3 m^3/h. These climate parameters were controlled in real time from a central control panel placed outside the room. The climate parameters were also measured at the animal level using a portable datalogger (Delta OHM). Animals were feeded, cleaned and managed for the trial from one single operator.

2.1. Heat stress trial

Groups of two or three piglets, out of the 20 piglets available, were assigned to high-temperature treatments (29 °C up to 41 °C) to simulate specific behaviours and vocalisations. This increase was designed to induce heat stress because normally the temperature in the pen was maintained within the comfort zone throughout the time that the animals were kept in the experiment room. During the trial, a small, randomly selected, group of 2 or 3 piglets was placed into a mobile solid-wall crate with dimensions of 0.5×0.5 m^2 up to 0.7×0.7 m^2 to isolate them from the rest of the group and facilitate our measurements. These dimensions also allowed a space allowance of 0.2 m^2 to 0.3 m^2 as per the CEE/88/2001 requirements such that a certain separation among animals was kept possible and avoiding further stress and competitive vocalizations.

This crate was placed inside the pen where the animals were normally living. On top of this crate, two infrared lamps (150 W) were hung 50 cm above the animals (Figs. 1 and 2). These types of lamps are routinely used for nest heating in farrowing rooms.

Each piglet was tested for heat stress reaction two, up to five times during the whole experimental trial period. Animals turnover was random such that groups were not of fixed mates.

The piglets were placed inside the crate and allowed to adapt to the smaller environment of the crate for approximately 30 min. Their reaction to newer environment was visually observed, from above the crate, by the operator (crate exploration, interaction with mates) as well as their vocalizations were recorded. As they started lying down, the infrared lights were turned on, and the measurements began. The temperature inside the crate was measured at time 0 (t_0) and after 20 (t_1), 40 (t_2) and 60 (t_3) min using a standard mercury-glass thermometer placed on the wall of the crate at floor level. Either water or feed was available in the test crate. In total 25 trials were repeated along the 120 days and each piglets was on average tested three times during the whole experimental period.