Sound Analysis toward heat stress assessment in swine farming

Sara Ferrari, Annamaria Costa, Marcella Guarino, *Department of Veterinary Sciences and Technologies for Food Safety, Faculty of Veterinary Medicine, Universita degli Studi di Milano, Via Celoria 10, 20133 Milano, Italy, sara.ferrari@unimi.it*

Vasileios Exadaktylos, Daniel Berckmans. *Department of Biosystems, Division M3-BIORES, Katholieke Universiteit Leuven, Kasteelpark Arenberg 30, 3001 Heverlee, Belgium*

Heat stress is widely recognized as a stressful condition that affects most livestock populations among several latitudes and in Europe especially during the summer months where high intensity hot weather patterns are referred to as heat waves. In intensive swine farms this stressful condition affect animal behaviour, welfare and production quality. Generally pigs respond to high ambient temperature by nutritional and physiological adaptation to maintain homoeostasis: a decrease of the average daily feed intake to limit heat production and an increase of respiratory rate to remove excess heat. Beside, behavioural reactions to distress exist including animal vocalizations. This research will observe and record several animal vocalizations from piglets bred in standard intensive conditions coupling them with environmental and physiological parameters. Animal vocalizations were recorded in group of seven weaned piglets, bred in standard intensive conditions, exposed to increased temperature.

Heat stress trials have been performed at the experimental farm of the Milan Veterinary. The average initial live weight of animals was 4,92±0,35 kg. Piglets were housed in a mechanically ventilated building. Room temperature was adjusted for thermal comfort zone of weaned piglets ranging from 32,2°C, to 25,2°C in the last week of the trials. Relative humidity ranged from 20 to 30% and ventilation rate was 3 m^3h^{-1}

Two or three piglets were assigned to high temperature tests (29°C up to 41°C for 1 hour), in order to stimulate specific related behaviours and vocalizations. During the trial, the piglets were placed in a test crate on top of which two infrared lamps (150W) were hung 50 cm above the animal. Temperature inside the crate was measured at time 0 (t_0) and after 20 (t_1), 40 (t_2) and 60 (t_3) minutes using a standard mercury glass thermometer. Rectal temperature was measured at t_0 and t_3 from a commercial digital pocket thermometer. Respiration rates were determined by counting flank movements and recorded as frequency per minute at t_1, t_2 and t_3. Vocalizations were recorded for one hour during every trial with a long gun directional microphone placed on the top of the crate 50 cm above the animals. The sensor was connected to the external microphone input of a handheld digital recorder and sounds were recorded, as uncompressed WAV files 24-bit and 44.1 kHz sample rate, on a SD flash media. Normal activity sounds (e.g. games) were also recorded. Audio playbacks were processed using Adobe® Audition® 3 to label vocalizations from piglets before and during the trials. Sounds were manually divided in two main groups Heat Stress (HS) and Non Stress (NS) and analysed for peak frequency (fig.1). Climate and acoustic data were coupled using the Pearson Correlation procedure of SAS 9.2. Pig weight, room temperature (T) and relative humidity (RH), test temperatures: t_0, t_1, t_2, t_3, respiratory rate (RR) at t_1, t_2, t_3, rectal temperature (RT) at t_0, t_3 and number of heat stress vocalizations were considered in the model. One-way Anova was also performed over the peak frequency calculated on HS and the NS sounds to examine the effect of high temperature exposure on the acoustic quality of vocalizations to search a discriminant for an automatic sound classification. Rectal temperature measured at t_0 and t_3, of the HS trial, showed a smooth increase 0,41°C from 39,3°C to 39,71°C positively associated ($P<0.05$) to the increase of air temperature from t_0 to t_3 ($\mu\Delta t= 5\pm 3$°C) and with the RR ($P<0.05$). The latter increased from t_1 to t_3 (34 to 116 bpm). RR and increased Δt were correlated for 91% ($P<0.001$) during HS. RR was also correlated ($P<0.05$) with animal weight and animal growth (52%; $P<0.05$). During these HS tests 991 sounds were collected while 442 vocalizations came from normal group situations recordings. Peak frequency analysis allowed distinction

Please cite as:
S. Ferrari, A. Costa, M. Guarino, V. Exadaktylos and D. Berckmans. Sound analysis toward heat stress assessment in swine farming. *Third International Symposium on Acoustic Communication by Animals*. Ithaca, USA, 1–5 August 2011.

between two types of sounds according to their energy content. Most sounds analysed (89%) had peak frequency lower than 1 kHz both for HS and NS and they were classified as “grunts”. Sounds that exceed the 1 kHz were significantly less frequent and due to their high frequency were classified as “screams”. HS grunts were positively related with RT and rising temperature in the test crate (P<0.001). HS screams occurred the most during the central 20 minutes period and were negatively correlated (P<0.001, -78%) with the room temperature. Screams didn’t show any relevant correlation with climate parameters involved in HS. The comparison between peak frequencies of all HS and NS sounds demonstrated relevant difference (P<0.001). During this trial the increase of RT was directly associated with higher temperature in the trial crate and with RR showing the efficacy of this method to induce heat stress in the piglets for these, we can assume the vocalization recorded during the trial are typical of HS and that animals in distress emit great amount of specific sounds (991 HS vs 442 NS). The comparison of the peak frequency showed acoustic differences between HS and NS which is crucial for the development of an intelligent algorithm to count and classify heat distress sounds.

Understanding negative animal responses and observing and recognizing animals in distress is a key skill to implement appropriate practices in order to reduce the stress effects. A possibility toward this goal is applying sound analysis, in livestock farming compartments, as a tool for early detection of disease and distress from continuous recording and automatic processing of animal sounds. Vocalisation must be considered as good indicator to assess heat stress as well as physiologic parameters, climate or feed intake are widely. Nowadays intensive sustainable livestock farming require advanced planning of production management systems which may adapt dynamically to the animals conditions.

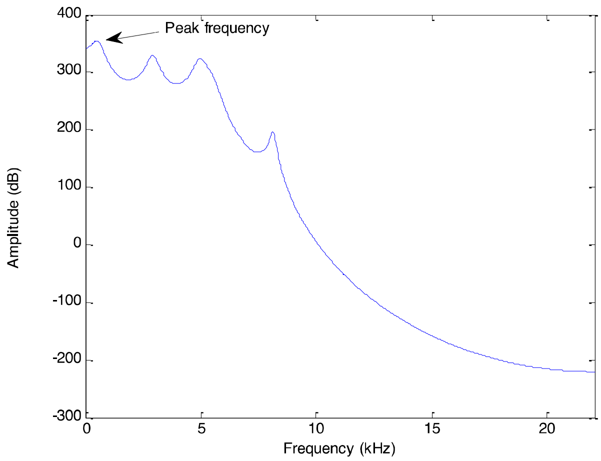

Fig 1. Smoothed AR spectrum estimated for each sound to measure frequency with the highest value Matlab® 2009b.

Aknowledgment: this work is part of a research project called “Integrazione di Sistemi Tecnologici Innovativi per il Monitoraggio a Distanza di Animali” financed by PRIN MIUR 2008, area 07, prot. 20088YWZ28.

Please cite as:
S. Ferrari, A. Costa, M. Guarino, V. Exadaktylos and D. Berckmans. Sound analysis toward heat stress assessment in swine farming. *Third International Symposium on Acoustic Communication by Animals*. Ithaca, USA, 1–5 August 2011.