ARTICLE IN PRESS

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/issn/15375110

Special Issue: Engineering Advances in Precision Livestock Farming
Research Paper

Use of vocalisation to identify sex, age, and distress in pig production

Alexandra F.da S. Cordeiro [a], Irenilza de A. Nääs [a,*], Felipe da Silva Leitão [b], Andréia C.M. de Almeida [b], Daniella Jorge de Moura [b]

[a] Paulista University, Graduate Program in Production Engineering, Agricultural Production, Brazil
[b] The State University of Campinas, College of Agricultural Engineering, Brazil

ARTICLE INFO

Article history:
Published online xxx

Keywords:
Pig welfare
Acoustic signals
Pig production
Machine learning

To assess animal welfare at a pig production farm is a time-consuming task. The present study aimed to investigate the differences in pig vocalisation as a function of the sex, age, and distress conditions, and to propose a way of identifying distressful situations. The individual vocalisations of 40 pigs were recorded (20 male and 20 female) during exposure to different distress in the farrowing, nursery, growth, and finishing phases. Vocalisation pitch differed between males (194.5 Hz) and females (218.2 Hz). Pig vocalisation was also different according to age, especially for the attributes of maximum and minimum amplitudes, and the frequency of formant 2. Diverse distress situations also were identified by various acoustic attributes. A decision-tree for classifying the distress condition for pigs was built (with an accuracy of 81.92%) using the machine-learning technique. Results indicate the possibility of estimating pig welfare by recording the vocalisation. The algorithm is also promising to identify pig sex and age.

© 2018 IAgrE. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Pork is the world's most consumed meat (SI, 2017), and the increase in pig production requires improvement in animal welfare status at the farm level. Assessing pig welfare is a time-consuming task, and new technologies are necessary for evaluating pig well-being in real-time (Dawkins, 2016). The variables used to estimate welfare status in pigs include the rearing environment (dry bulb temperature and relative humidity), physiological indicators (body temperature, cortisol level, respiratory frequency, and immunological response), and various group behaviours (fights, social interactions, and vocalisation) (Kranendonk, Hopster, Fillerup, Ekkel, & Mulder, 2006; Candiani et al., 2007; Fagundes et al., 2008). Observation and recording of the majority of these variables on the farm are challenging and time-consuming and therefore an automatic way of assessing welfare is highly desirable.

Several authors consider vocalisation to be an efficient tool to estimate pig well-being and health (Ferrari, Silva, Guarino, & Berckmans, 2008; Marx, Horn, Thielebein, Knubel, & Borell, 2003; Moura et al., 2008). Vocalisation recording has been efficient in identifying several distressful situations in

* *Corresponding author*. Paulista University-UNIP, Rua Dr. Bacelar 1212, CEP 04026-002, São Paulo – SP, Brazil.
E-mail address: irenilza@gmail.com (I.A. Nääs).
https://doi.org/10.1016/j.biosystemseng.2018.03.007
1537-5110/© 2018 IAgrE. Published by Elsevier Ltd. All rights reserved.

Please cite this article in press as: Cordeiro, A. F. S., et al., Use of vocalisation to identify sex, age, and distress in pig production, *Biosystems Engineering* (2018), https://doi.org/10.1016/j.biosystemseng.2018.03.007

ungulates (Dupjan, Schön, Puppe, Tuchscherer, & Manteuffel, 2008; Tallet, Linhart, Policht, Hammerschmidt, & Šimeček, 2013), as well as in the detection of a pig cough (Exadaktylos, Silva, Aerts, Taylor, & Berckmans, 2008), and in the identification of respiratory disease in bovines (Vandermeulen et al., 2016). Vocalisation has been used to differentiate male and female for birds (Pereira, Naas, & Garcia, 2015) and baboons (Fischer, Hammerschmidt, Cheney, & Seyfarth, 2002). Pereira et al. (2015) found that the acoustic attribute formant 2 can be used to separate broiler chicks by sex. Fischer et al. (2002) established that baboon males emit higher frequency and shorter duration acoustic signals when compared to females. Erb, Hodges, and Hammerschmidt (2013) identified a change in the vocalisation of primates of different ages. The use of broiler vocalisation allowed bird age (Fontana, Tullo, Scrase, & Butterworth, 2016) and weight (Fontana et al., 2017) to be estimated. There is a lack of information as to whether vocalisation correlates with age or sex in pig production.

Vocal sounds can be recorded remotely allowing assessment of population size and species composition, individual behaviour and specific interactions (Blumstein et al., 2011). A typical vocalisation recording produces a significant amount of data. The analysis of sound recordings can be time-consuming and subjective when done by visual examination of sonograms.

Tolon et al. (2013) estimated the welfare of sows using the sound waves emitted by the animals. The attributes such as amplitude, frequency, and the pitch have been used in assessing pig welfare (Moura et al., 2008; Moi et al., 2015; Tolon et al., 2013). The use of the different pig's vocalisations has not yet been fully used on commercial pig farms. However, there is substantial evidence that, besides the anatomic differences in young pigs, the use of vocalisation might be a way to separate the animals by sex in pig herds.

Machine learning has been successfully employed in animal vocalisation studies (Valletta, Torney, Kings, Thornton, & Madden, 2017), as well as in the classification of calls (Acevedo, Corrada-Bravo, Corrada-Bravo, Villanueva-Rivera, & Aide, 2009; Tchernichovski, Nottebohm, Ho, Pesaran, & Mitra, 2000). The machine learning focus is used typically on a prediction; without necessarily assuming a functional distribution for the data (Valletta et al., 2017). Therefore, this method becomes a proper choice for dealing with complex data sets. Vandermeulen et al. (2015) developed a classifying algorithm for detecting pig screams and acquired good results (71.83% of sensibility, 91.43% of specificity, and 83.61% accuracy). The present study aimed to investigate the differences in the vocalisation of pigs as a function of age, sex, and distress conditions, and to develop a decision-tree algorithm to help identify distress situations during pig production.

2. Material and methods

2.1. Animals and husbandry

The experiment was set in a commercial pig farm located in the city of Holambra, São Paulo State, Brazil, latitude 22° 37′ 59″ S and longitude 47° 03′ 20″ W. The pigs were housed in a solar house oriented East-West, with a height of 3.5 m in the sides. There was a lateral wall 1 m high. The sides were partially open, and a polypropylene curtain was used to control the size of the side opening. Clay tiles were used on the roof. The farm reared the pigs through the complete production cycle. Sows were inseminated and stayed in groups during gestation. Piglets were raised with the sows during farrowing up to 21 days old when they were weaned and transferred to the nursery, where piglets stayed until 60 days old. After this age, the pigs were again relocated to the growing and finishing area until they reached 100 kg. From this unit, the pigs were transported to the slaughterhouse. During the experimental period, the piglets had water and feed *ad libitum* after weaning. The pigs were identified at birth using a pair of notching pliers.

The vocalisation of 40 pigs (20 male and 20 female) were recorded in different distress conditions in four phases of growth (farrowing, nursery, growing, and finishing), as shown in Table 1. The normal state (baseline) was adopted as the standard pig reared on a commercial pig farm with proper rearing environment and feed and water given *ad libitum* to the animals. During the cold stress, the piglets in the farrowing stage were subjected to an ambient temperature of 25 °C for 30 min, and in the nursery phase to a temperature of 22 °C for 1 h. The cold stress was applied by turning off the heating systems. Heat stress was provided by turning off the axial fans associated with the closing of the side curtains to avoid natural ventilation for 1 h. The ambient temperatures reached 27.5 °C inside the growing house and 30 °C in the finishing house.

During the farrowing stage, the piglets were exposed to hunger and thirst by the restriction of nursing for 30 min. Hunger distress in the nursery, growing and finishing growth phases was induced by restricting access to feed for 1 h. Thirst was caused by restriction of water for 1 h in the all growth phases. Pain consisted of a squeeze to the mid-torso, firmer than a simple restraint by the animal handler. After the sound recording, the pigs were put to rest for at least 2 h, before being tested again.

The piglets were marked from 1 to 40 before the beginning of the experiment. During the recording of data, the pigs were marked again on the torso using a proper coloured pencil/toner to help the identification of the animals. The vocalisation of each animal was recorded in each distress condition in every studied phase. After each sound recording, the data obtained were documented using the number of the pig, the growth phase and the distress condition to which the animal had been exposed. The field trial was approved by the Ethics Committee, Unicamp, n. 2224-1/2011.

2.2. Sound acquisition and analysis

A unidirectional microphone (Yoga Ht-320a, Taiwan) was positioned approximately 20 cm from the pigs to record the vocal sounds. The microphone was connected to a digital recorder (Marantz PMD660/U3B Compact flash recorder, Japan) and the signals were digitised using a frequency of 44,100 Hz. The sound emitted by each pig was recorded for 60 s. The sounds recorded were edited and analysed using the software Praat®. Each signal recorded was divided into three samples, and from each sample (20 s), ten acoustic attributes were extracted and analysed (Table 2).

Data were subjected to ANOVA, and the Tukey test was used to establish significant differences in mean values at 95% probability. Regression analysis was used to define the best-

Download English Version:

https://daneshyari.com/en/article/11019827

Download Persian Version:

https://daneshyari.com/article/11019827

Daneshyari.com