Vocalization as a measure of welfare in slaughter pigs at Danish slaughterhouses

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***Abstract*— Documentation of animal welfare in the entire production chain is an increasing demand from authorities and the market. One possibility of monitoring welfare at the slaughterhouse could be to measure the sound produced by the pigs, and correlate the sound to the corresponding behaviour and thereby use these measurements as an estimate of animal welfare. The aim of this study was to describe typical pig vocalizations at slaughterhouses and afterwards correlate them with the actual behaviour.**

Vocalizations were recorded during visits to three Danish slaughterhouses. Fifty different sound tracks were initially identified. By ear, nine different vocalizations have been identified and selected in the slaughterhouses as the most common vocalizations: Grunt, deep grunt, complaining, startled, 'go away', short/middle/long scream and squeal. Afterwards, three plots were made per vocalization: Amplitude plot as a function of time; power spectrum as a function of frequency; spectrogram made from 10 ms windows. Data from the power spectrum were analysed by multivariate analyses in order to find correlations between the vocalizations.

It was concluded that it is possible to discriminate between various vocalizations at slaughterhouses by sound measurements. This is the fundament for a continuous monitoring of animal welfare using sound measurements at the slaughterhouse. However, much more work is needed to implement sound measurements as a tool for welfare documentation in practice.

Keywords— **Animal welfare, pig, vocalization, measuring system.**

I. INTRODUCTION

Documentation of animal welfare in the entire production chain is an increasing demand from authorities and the market. Formerly, DMRI has contributed to the development and test of ethical audits as an instrument for documenting animal welfare at the slaughterhouse [1]. However, ethical audits are not meant for the routinely based surveillance and documentation of animal welfare. In the EU project 'Welfare Quality®' indicators for animal welfare in the primary production and at the slaughterhouse were identified [2]. Welfare Quality® has included a section for measuring pig welfare at slaughterhouses, but has not yet included an actual "Calculation of scores for finishing pigs" in the protocol. Furthermore, the suggested criteria are not useful on a routinely basis. Therefore, there is a need for simple methods and systems monitoring and documenting animal welfare at the day of slaughter. Automatic registration of welfare indicators as documentation of the level of animal welfare could be a useful tool for the slaughterhouses and meat producers. Surveillance of animal welfare indicators would not only be an opportunity to fulfil the demand of documentation from authorities and the market but could also be an operational way to control and improve the handling of the animals at the slaughterhouse. One possibility of monitoring welfare continuously at the slaughterhouse may be to measure the sound produced by the pigs and correlate the sound to the corresponding behaviour, thereby using these measurements as part of an overall estimate of animal welfare. When the pigs call out, the vocalization is related to an emotion and it indicates some kind of "need". It seems like the vocalizations may give an indication of the pig's well-being and accordingly the welfare state [3]. Therefore, sound analysis can be a well-suited and valid tool for the evaluation of welfare and stress [4], [5] and the emotional state of the pig [6].

Studies have been performed on farms and research facilities in order to investigate the vocalization of pigs. Some even focus on the transportation of pigs, but close to none have dealt with the vocalization of pigs at slaughterhouses.

The lack of information relating to knowledge about vocalizations at slaughterhouses is the motivator for this study.

II. TEST

Objectives

The aim of this study was to describe typical pig vocalizations at slaughterhouses and afterwards correlate them with the actual behaviour.

Material and method

First of all, pig vocalizations were recorded at two Danish slaughterhouses using a Karsect KRU-6 combined with a Midiplus Audiolink USB Audio Interface, wireless microphone and Audacity audio editor and recorder. Based on these registrations, different types of vocalizations were identified by ear. Afterwards, a larger experiment was set up at a 3rd Danish slaughterhouse including sound recording, behaviour studies and meat quality assessment. Four batches in total, each consisting of 60 pigs, delivered twice a day during the two experimental days, were included in this experiment. The 60 pigs were divided into two groups of 30 pigs and placed in two pens. The sound was digitally recorded with 'Karsect KRU-6 equipment'. The microphone was placed one meter above the floor in the middle of the two observed pens. Fifty different sound tracks were initially identified. Vocalizations were identified by ear. Afterwards, three plots were made per vocalization: Amplitude plot as a function of time; power spectrum as a function of frequency; spectrogram made from 10 ms windows (Fig. 1). Data from the power spectrum were analysed by multivariate analyses in order to find correlations between the vocalizations.

During lairage, animal behaviour has been observed every 5th minute and registered as follows:

- Pigs standing, sitting or lying
- Exploration
- Indicative aggression
- One or two-way aggressions or short term fights lasting less than 10 second
- Long term fights lasting 10 seconds or more

Right after sticking, blood and carcass temperature were measured and pH of the loin determined. Skin damages due to fighting were assessed using the four point DMRI scale indicating the level of skin damage (none – severe). The day after slaughter, meat quality was assessed by measurement of pH and drip loss in the loin and ham.

Results

By ear, nine different vocalizations have been identified and selected in the abattoirs as the most common pig vocalizations: Grunt, deep grunt, complaining, startled, 'go away', short/middle/long scream and squeal. After the initial identification of the vocalizations, each defined vocalization was supposed to undergo extensive analysis. Several parameters are relevant when defining a vocalization: duration, relative amplitude, frequency, fundamental frequency, formants and sound pureness. Other parameters like pitch and pitch change might also be of relevance in order to define these vocalizations.

The nine vocalizations and the parameters chosen are shown in table 1 and 2. An example of the three plots per vocalization (short scream) is shown in Figure 1. Thus, some of the defined sounds are quite similar. Further analysing the sounds should make it possible to make a much more clear definition of each sound. This could possibly be applied to the sounds 'deep grunt' and 'complaining'.

Furthermore, the scream should probably not be divided into three categories (short/middle/long) unless they can be related to different behaviour or a deviating effect on the assessed welfare parameters. Classification of specific pig vocalizations is performed by regarding three aspects: (1) the behavioural context in which the call has been made; (2) the distinction of individual vocalizations amongst pigs; and (3) the differentiation of particular calls, e.g. stress calls, from other calls [7]. It has to be investigated if some of the sounds are correlated to high animal welfare while other sounds are more stress related. These analyses still have to be made as the sound analyses are more time consuming and complicated than expected. For that reason, we still have a lot of work to do.

Table 1. Nine identified vocalizations

Grunt
Deep grunt
Complaining
Startled
'Go away'
Short scream
Middle scream
Long scream
Squeal

Table 2. Parameters describing vocalizations

Duration
Relative amplitude
Frequency
Fundamental frequency
Peak frequency
Formants
Sound pureness

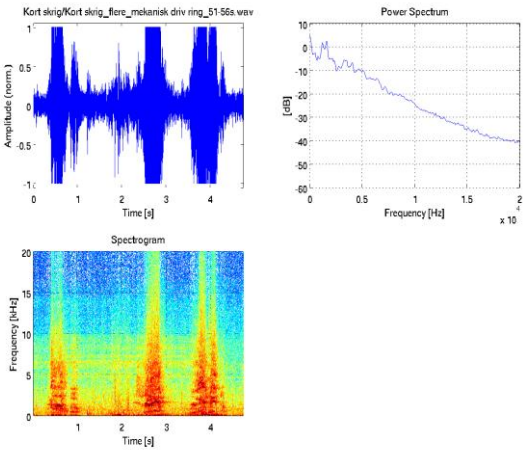

Fig. 1 Short scream – Amplitude plot; power spectrum; spectrogram

III. DISCUSSION

Nine different vocalizations have initially been defined based on visits to Danish slaughterhouses. After extensive analysis one might find that some of the vocalizations are related to the same behaviour or represent similar welfare characteristics and thus a merging of these vocalizations may be an advantage.

In these preliminary studies, the microphone was placed one meter above the floor in the middle of the two observed pens. For some of the sound measurements, an overload was present making the sound analysis impossible. The precise position of the microphone is not totally agreed upon. Generally the sound is measured about 0.5 metres above ground level i.e. [8], but microphones can be placed up to 2 meters above the floor [9], directly in front of the pig's snout [10] or in the centre of the room [11].

In all cases it is important to realise that when measuring sound intensity (amplitude) in vocalizations expressed by animals, the distance between the microphone and the animal is continuously changing. The placement one meter above the floor in the pens seems to be acceptable for the sound measurements during the conditions chosen in our study.

The frequency of the various sounds should be related to the assessed animal welfare indicators in order to investigate to which degree the general animal welfare status of the pigs can be predicted based on the sound measurements. However, as the sound analysis is not straight forward, this work still has to be made.

At present, some sound analysis system is already available. STREMODO is a stress monitor and documentation unit. The system detects stress screams from pigs and automatically registers the time of occurrence, the duration [12] and the intensity of the calls, but not the number of individual screams [9]. STREMODO can be applied to several areas of the farm animal production system, i.e. commercial farming, during transportation and in the slaughterhouse [12]. The fact that STREMODO is a real-time computer-based system delivering objective and reproducible results, and due to its large insensitivity to noise and non-stress vocalizations makes the system reliable when analysing pig stress calls [9]. But if there is a need of analysing non-stress calls, like grunts, it is necessary to use another system. That is why we have tried to look further into the different vocalizations including formant analysis.

Further work will be initiated by an industrial Ph.d.

It has to be underlined that continuously monitoring animal welfare e.g. by sound measurements are not meant to stand alone. Sound measurements are solely

an instrument to monitor and document animal welfare. The surveillance has to be supplemented by action at the slaughterhouses with regard to changing and improving facilities, equipment, behaviour of the operators etc.

IV. CONCLUSIONS

It was concluded that it is possible to discriminate between various vocalizations at slaughterhouses by sound measurements. This work is the fundament for a continuous monitoring of animal welfare using sound measurements at the slaughterhouse.

ACKNOWLEDGMENT

The authors would like to thank the Pig Levy Fund for financing this research.

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