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Study on Acoustic Features of Laying Hens' Vocalization

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Abstract. In this paper, vocalizations of laying hens (Hyline Brown) were focused. An experiment was designed to obtain acoustic features of laying hens with different ages: 35days-old, 95days-old and 125days-old. Vocalizations were recorded by the microphone MPA201. Analysis was done by some analytical software in order to gain time-domain features and frequency-domain properties of laying hens' sound. The duration time, pitch frequency, formant track and spectrums of vocalizations were all included. Results showed that some characteristics of vocalizations of laying hens with different ages were dissimilar when under given state. It was proved that the vocalization of laying hens could be recognized and identified.

Keywords: vocalizations, spectrums, laying hens, time structure

1 Introduction

Vocalization is a common response to the emotional state of an animal, which could be used to attract the opposite sex, search companions, look for food, convey danger signal, play and communicate with each other. Study on the vocalizations of animals is not just to identify wild animal species, but also the physiological state of livestock and poultry can be monitored (He et al., 1996; Jiang et al., 2003). The characteristics of animals' sound were concentrated, especially the time-domain features and frequency-domain properties (Sanvito et al., 2007). Which could provide a theoretical basis for the establishment of voice-based animal welfare assessment system and health warning system by deep study of animals' vocalization.

Vocalizations of laying hens are quite different when under distinct patterns. Laying hens were thought to express an expectation of a rewarding event through a specific vocalization, which could serve as an indicator of laying hens' welfare (Zimmerman et al., 1998; Manteuffel et al., 2004). Vocal expressions of 50 chicks were analyzed during step by step social isolation. Results showed that vocalizations of laying hens were strongly dependent on social contacts and could be changed when under different degrees of social deficits (Marx et al., 2001). Pecking behavior in individual and social condition was compared in two lines of laying hens at ten different ages. Vocalizations were recorded as well to measure the response to isolation in the test (Rodenburg, et al., 2003). This study was to

analyze the acoustic features of vocalizations of Korean native cows and to examine the differences between estrus and feed anticipating vocalizations (Seong, et al., 2006). The fear reaction of three different genetic strains of laying hens to a simulated hawk attack in a free-range system was tested. It was concluded that they were similar in the behavior or vocalizations (Christina et al., 2005; Zeltner, et al., 2008).

At present, research to the relationships between vocalizations of laying hens and their living behavior were studied more. But the characteristics of laying hens (Hyline Brown) were not focused so much. Here was illustrated a simulation of flat breeding model of laying hens in laboratory. An experiment designed was to obtain the acoustic features of vocalizations of laying hens (Hyline Brown) to find the changes with different ages.

2 Materials and methods

2.1. Animals and data collection

The amount of animals used in this experiment was 30 laying hens. The breed was Hyline Brown (U.S. standard). Ten were 35days-old, 95days-old were ten and the others were 125days-old. They were housed in a 1.5×1.0×1.0m (length× width× height) breeding pen respectively. The temperature inside the pen ranged from 20 to 30℃ at a relative humidity between 35 and 45%. Laying hens were placed under 8h light/16h dark (lights on 09.00) using a 25W incandescent electric bulb in each pen (Christina et al., 2005; Seong et al., 2006). They were free to drink and eat. Vocalizations of laying hens were recorded from November to December in 2007. Every record lasted 0.5h with half-hour interval from 09.00 to 17.00 each day. All vocalizations were collected using a microphone (MPA201, Bswa Technology Ltd, P.R. China) set at the top of the pen.

2.2. Sound measurement

Sound was sampled by the PXI test platform (PXI-1050, National Instruments Ltd, USA) at a rate of 44.1 kHz using a 24 bit sound acquisition card (PXI-4472B, National Instruments Ltd, USA). The sound files were analyzed using Cooledit Pro 2.1 (Syntrillium software, 2003) and Praat4.6 (Boersma P & Weenink D, University of Amsterdam, The Netherlands). Cooledit was used to edit the sound files which served for the analysis of vocalizations by Praat (Zimmerman et al., 1998; Marx et al., 2001). Main algorithm in the acoustic field developed by Praat which can be used to obtain time-domain features and frequency-domain properties of vocalizations of animals.

2.3. Statistical analysis

All statistical analysis was performed using SPSS 16.0 for Windows (SPSS Inc., 2005).

3 Results and discussion

Vocalizations of animals are similar to human language, which have complex changes and different meanings (Chen et al., 2009). But animals can't speak out by themselves like human. So it is very important for people to understand what meaning of the vocalization of animals. Voice processing technology can also be used for animal research.

Generally, sound of laying hens is mainly composed of monosyllabic tweet. The syllable frequency of the sound of laying hens will be changing when under different stage ages. Digitalizing the vocalizations of laying hens need to treat the monosyllabic tweet as an identification unit (Wang et al., 2005; Mair et al., 2000). In data processing, vocalizations of laying hens with different ages were randomly selected to execute syllable segmentation. Four-hundred and fifty calls were selected in order to get the acoustic characteristics of laying hens.

3.1. Time structure

Wave and frequency of laying hens on 35days-old, 95days-old and 125days-old were shown below. Spectral envelope curve of laying hens' vocalizations were typical. The pitch frequency of laying hens was not less than 5000Hz.

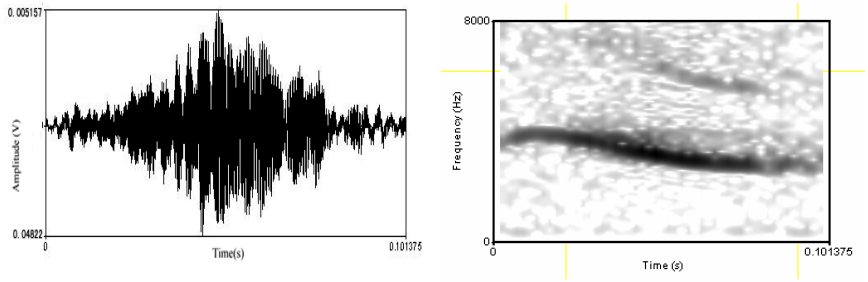

Fig. 1. Wave and frequency of laying hens on 35th day

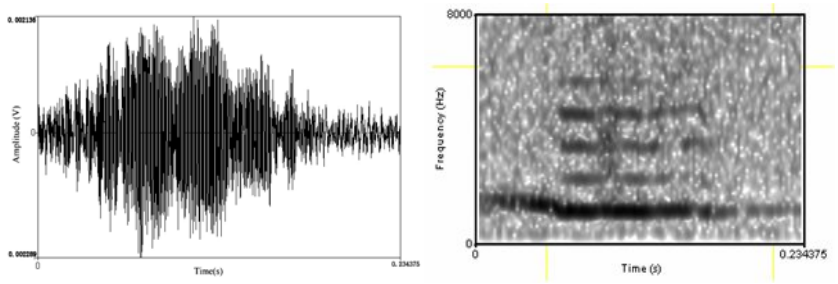

Fig. 2. Wave and frequency of laying hens on 95th day

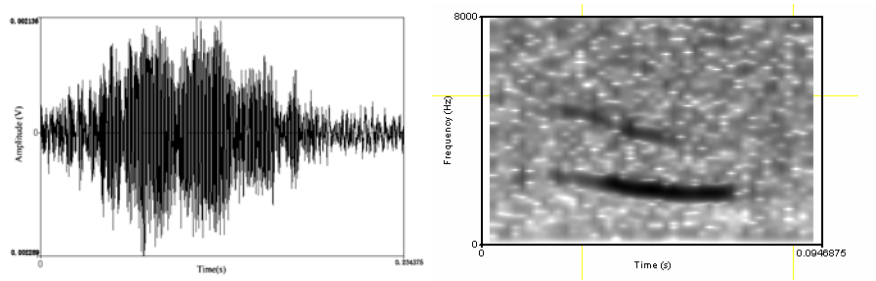

Fig. 3. Wave and frequency of laying hens on 125th day

The syllable duration of laying hens was distributed between 50ms and 200ms. The durative time of vocalization with 125 day old and 95 day old was significantly less than 35 day old. No distinct differences were found between 95days-old and 125days-old of laying hens.

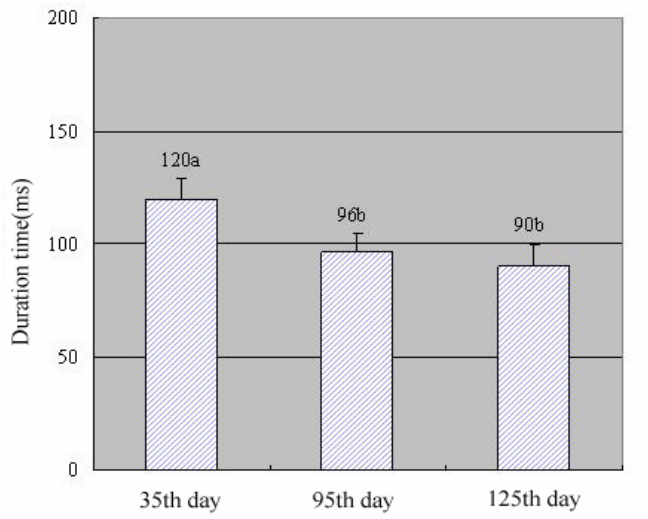

Fig. 4. Duration time of laying hens under different days

3.2. Spectrums

The following chart revealed the spectrums of laying hens with different ages. From the illustration we can inform that the spectrums of laying hens were relatively simple. The composition of each syllable slightly differed. But there were significant differences among the energy center on sound of laying hens under different days. The frequency of energy center of laying hens were more than 2000Hz, on 125th day was the highest, 35days-old was lower, and the last one was 95days-old. It is possible to judge which growing period of laying hens through analyzing the energy center frequency of their vocalizations.

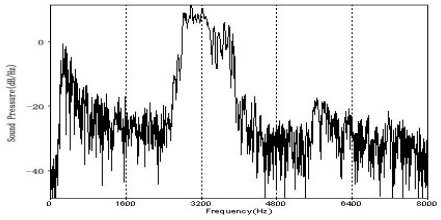

Fig. 5. Spectrums of laying hens on 35 th day

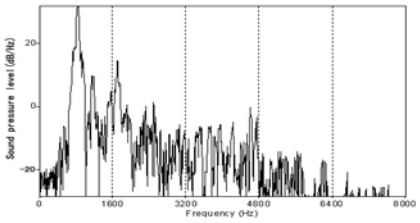

Fig. 6. Spectrums of laying hens on 95 th day

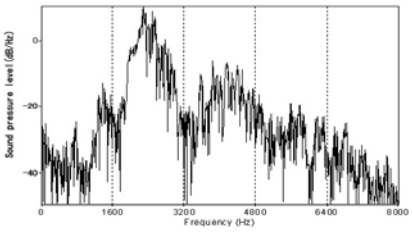

Fig. 7. Spectrums of laying hens on 125 th day

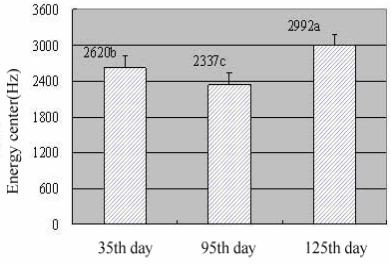

Fig. 8. Energy center on sound of laying hens under different ages

4 Conclusion

In this paper, vocalizations of laying hens (Hyline Brown) with different ages were analyzed and compared. From this, we could grasp the variation law of the basic characteristic parameters of laying hens' vocalizations. The results showed that the duration time and energy center on sound of laying hens existed with different ages under normal feeding; even the trend of variation was not the same. Therefore, we could understand the growing period of laying hens from the analysis of their vocalizations. But if we want to achieve automatic identification and classification, the representative acoustic feature parameters must be extracted. There provides as a theoretical basis for the establishment of voice-

based animal welfare assessment system and body health warning system to improve animal welfare.

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