Changes in the characterization of newborn bird vocalisations during first 48-h of life-hours

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Abstract

In poultry farming, the chicks hatch in incubators without their mothers' warmth and contact. After the hatch they are transferred from their birthplace to the farm where they will grow up. The first 48 hours of life become a crucial time for the chicks since they must face various stressors to survive and continue their growth process. These stressors affect the physical, biochemical, and hematological parameters of the birds. In this study, an acoustic analysis, focused both in temporal and spectral information, is carried out during the first 48 hours of life of two groups of birds, splitting the animals into a group to which an early feeding is administered, and a group under fasting conditions. The objective of the study is to compare the acoustic parameters of the two groups of birds to deduce whether the administration of a feed support can mitigate the stressors compared to the control group.

Keywords: vocalisation, bioacoustics, poultry, welfare, newborn.

1 Introduction

Bioacoustics is the study of the production, transmission and reception of sounds emitted by animals. This interdisciplinary science can be used in ecology and conservation, for example for the detection of animals and/or species, for the monitoring of a population, to verify how human activities can influence animal behaviour. Thanks to the technological progress of the last decades, bioacoustics analysis is becoming more and more automated, the use of sensors collecting data allows to avoid human presence while the field recordings are being conducted, minimizing the interference in the farm environment. Most of the studies on animal welfare focus on reducing the potential negative experiences coming from their life environment in the farm that could threat animal health. Thus, the goal becomes to improve environmental factors, such as light, stock density, housing, disease prevention, disturbing noises, to prevent all those stressors that could negatively affect animal welfare [1].

The poultry industry is one of the fastest growing segments of the agricultural and veterinary sector. Nowadays, more than 40 billion chickens are produced annually worldwide. Broiler chickens are the most widely farmed fast growing species, with a stock population density that ranges from 10,000 to 30,000 birds. The substantial change in farming methods from extensive to intensive imposes a number of significant challenges for animal welfare and health, as well as for environmental sustainability and food safety [2].

One of the main and first stressors to which newborn broiler chicks are subjected to is prolonged fasting caused by the routine practices they are subjected to before arriving to their final farm growing location. The "hatch window" is the period in which the eggs of a stock are born, and can last from 24 to 48 hours. Once hatched, the chicks are selected, vaccinated, sexed, sorted and finally transported to the farm [3]. During all these practices, which can not exceed, by law, a period of maximum 72 hours, the chicks do not have access to water and food [3]. Prolonged deprivation of water and food can have long-term negative effects on the health and behaviour of the chick: it can hinder its growth and the correct functional development of the gastrointestinal system [4]. Thus, effective solutions to improve the effects of the lack of water and food should be found, to avoid the negative effects caused by prolonged fasting. A recent innovative method for ensuring nutrition intake from the first hours of life is the administration of hydrated gels that contain a growing variety of nutrients and additives [3].

The objective of this preliminary study is to simulate the fasting of the first two days of life (48 hours) of the newly hatched chicks, and to analyse the first results about whether the administration of the hydrated gel Licuicel® Complex (Cealvet S.L.u), can improve the health and well-being of the birds compared to a fasted control group. For this study, acoustic measurements will be carried out to analyse and compare the difference in acoustic patrons between the two groups and to develop metrics to infer, in an empirical way, the state of health of the animals. In order to have more data available about the chicks evolution, the acoustic study is supported by a haematological analysis.

2 Material and Methods

The study was conducted with 120 newborn broiler Ross 308. The birds were collected at hatching and transported (in one hour) to the study site where they were sorted into two main groups (Control –CON- and Licuicel -LIC-) of three replicates of 20 birds each. A quantity of 0,25 ml of Licuicel ® Complex hydrated gel was injected directly into the mouth of the LIC group's chicks. After one more hour of feeding the group, chicks were left in a 6m^2 room until the last 3 hours of the study, when CON group was moved to a similar room for individual recording data with identical equipment. The animal vocalisation collection process was non-invasive, by means of a professional handheld recorder (zoom H5 [5]) sampling at 44,100 Hz and 16 bits resolution connected to a directional microphone Behringer ultravoice XM1800S [6]. Acoustic data was first filtered between 1 - 5 kHz to avoid interferences of other sounds but vocalisation. Windows of 30 minutes of recorded data per class (NewBorn, Control and Licuicel) were manually analysed using PRAAT [7] for pitch detection, and Audacity [8] for spectrogram view and labelling.

Figure 1 – Experiment setup for the recording campaign of the bird vocalisations.

In order to widen the acoustic study, a haematological analysis was conducted to verify whether the data obtained at blood level could support the results of the analysis of the acoustic recordings, and thus deduce the health conditions of the chicks. At 48 hours of age, the chicks were transferred to a blood extraction center, the Cesac, in Reus (Spain), and blood samples were sent to the Echevarne Laboratory, in Barcelona (Spain), where haematological parameters, like the haematocrit (HCT), the haemoglobin, and the count of the different types of leukocytes, were analysed.

3 Acoustic Vocalization

Three visual analyses of spectrograms have been performed to detect visual differences in spectrotemporal vocalizations. Figure 2 shows three examples of the most common pattern of vocalisation for each class. Newborn and Control vocal pattern present similar results in frequency range and shape, even so control is a bit shorter in vocal duration. In contrast, Licuicel spectral pattern has a reduced frequency range compared to the others, and it also present the longest durations.

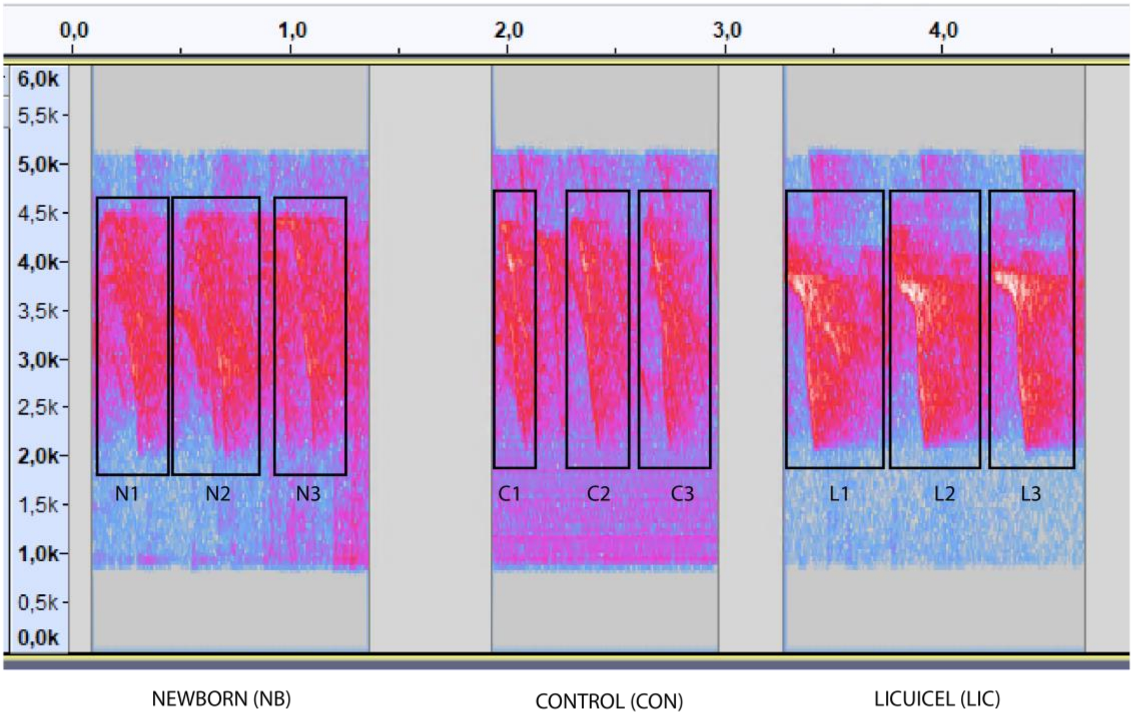

Figure 2 – Spectrogram of the three types of vocalizations.

Listening to the raw filtered audio of NB and LIC apart from hearing the vocalisations of the birds, the noise of the wing flapping and chick movement were usually heard and detected indicating activity versus the CON audio files where vocalisation was the predominant audio identification.

4 Acoustic Parameters Evaluation

Fast temporal repetitions of birds' vocalisations can be an indicator of stress according to [9]. Curtis et al., use an indicator of high number of vocalisations repetitions (from 160 to 250 vocalisations in 45 minutes) to detect a stressful condition [7]. In previous studies [10] a correlation has been found between maximum frequency vocalisation and food intake. Indicating that animals are better fed when frequency vocalisation evaluated is lower. Moreover, maximum peak frequencies of all the entire production cycle are found during the first three days of life on farm, when animals are stressed due to the transport and the new location adaptation. High pitch value are present together with high max frequency and are also indicators of stress.

By studying the pitch and number of vocalisation parameters, we have drawn a preliminary holistic view of the stress and well-being of the birds under test.

Table 1 – Acoustic parameters extracted at 48h of study life.

Block Num	Mean Pitch NB (Hz)	Mean Pitch CON (Hz)	Mean Pitch LIC (Hz)	Num vocal NB in 10s	Num vocal LIC in 10s	Num vocal CON in 10s
1	3589.5	3432.39	3293.02	35	34	29
2	3583.63	3586.87	3265.18	34	30	38
3	3606.46	3545.77	3301.75	34	26	31
4	3553.87	3564.43	3358.97	28	31	38
5	3441.61	3573.01	3351.18	31	37	36
6	3563.73	3800.23	3571.18	32	31	39
7	4003.34	3715.37	3332.64	21	31	37
8	3484.43	3765.64	3432.36	27	33	48
Mean	3603.32	3622.96	3363.28	30	32	37

In Table 1 shows the comparison between mean pitch frequencies and number of vocalisations in ten seconds per each class. In terms of maximum vocal frequency, no clear difference (19 Hz) is observed between NB and CON. Whereas there is a reduction of an average of 240 Hz in main vocalisation frequency of the animals under treatment. In reference to the temporal repetition of the vocalisations, there is an increase of number of repetitions in respect to the NB, while the animals without treatment vocalise in average five more times than the ones with Licuicel, which have only two more vocalisation in average.

5 Haematological Analysis

The results obtained from the haematological analysis highlight two parameters that were statistically significant, and that may be correlated to the acoustic data obtained. These parameters are the haematocrit value and the monocytes count (see Table 2).

The haematocrit values obtained in the LIC group are lower than those of the CON group. These results follow those obtained by [11], which suggest that water deprivation, resulting in dehydration, causes changes in blood parameters, particularly in haematocrit values, which increase abnormally when the animal is not able to maintain homeostasis.

The monocyte count of our study appears to be higher in LIC group than in the CON group. Pires et al. [12] contribution is aligned with that result; chicks under prolonged fasting had a lower percentage of monocytes than chicks fed immediately after hatching. The type and intensity of the immune response depends on the type and duration of stress, the age at which the stress is caused, and the degree of fasting [12]. Therefore, the stress caused by prolonged fasting causes a significant reduction in the number of monocytes compared to chicks that have access to a nutritional source right after birth.

Table 2 – Haematological Analysis

Parameter	Mean in CON	Mean in LIC	P value
Monocytes (%)	1.4667	3.1786	0.0038
Monocytes MM (µL)	281.6000	540.4286	0.0067
Haematocrit (%)	37.0333	34.8571	0.0343

6 Conclusions and Future Work

LIC group analysis, with the birds fed with the hydrated gel Licuicel® Complex, present indicators that show some stress reduction, according to both the acoustic and haematological analysis. The acoustic descriptors corroborate the differences in the visual spectrogram vocalisation pattern analysis. The LIC group shows a reduction of the pitch frequency when compared to the other groups. The number of vocalisations is very similar to the Newborns, maintaining the same call frequency compared with the Newborns that are not dehydrated.

The results obtained from the haematological parameters confirm a stress reduction of the LIC group's chicks compared to those of the CON group. The lower haematocrit values of the treated group indicate a lower level of dehydration, therefore a more efficient maintenance of the homeostatic balance. Also, the monocyte count, whose higher numbers in the LIC group suggest a lower stress state compared to CON group, is also in agreement with the acoustic parameters.

This study has worked with a small dataset, analysed manually. In future, an automatic algorithm based on artificial intelligence will be used to analyse the entire raw acoustic data to widen the focus of the analysis and improve the accuracy of the results. In addition, more acoustic descriptors will be tested to develop other acoustic descriptors that indicates stress of the animals.

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